UNSW Course Outline

ZEIT8221 Spaceborne Imaging Technology - 2024

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General Course Information

Course Code : ZEIT8221
Year : 2024
Term : Semester 2
Teaching Period : Z2
Is a multi-term course? : No
Faculty : UNSW Canberra
Academic Unit : School of Engineering and Technology
Delivery Mode : Online
Delivery Format : Standard
Delivery Location : UNSW Canberra at ADFA
Campus : UNSW Canberra
Study Level : Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course covers a range of topics relevant to remote sensing of the Earth's surface from space, including

- Optics for spacecraft imaging payloads
- Planck's blackbody radiation law
- Atmospheric transmission and atmospheric windows
- Wavelength ranges available for earth imaging and corresponding energy-matter interaction mechanisms
- Properties of different surface cover types
- Detectors in the visible and reflective infrared regimes and thermal detectors
- Imaging spectrometry
- Passive and active microwave sensing of earth surface features, including synthetic aperture radar methods
- Spaceborne imaging systems such as Landsat MSS and TM, Spot HRV, SIR A, B, C, ERS-1, JERS-1, and Radarsat and aircraft systems
- Image processing methods used in support of image interpretation, including traditional and machine learning classifiers.

Course Aims

The aim of this course is to provide an introduction to the technology and imaging systems used in remote sensing, and to generate an understanding of the methods used to extract usable information from the recorded data.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Apply Planck's black body radiation law and atmospheric transmission properties to explain how different wavelengths can be used in different types of remote sensing.
CLO2 : Apply optical theory to relate the design of space-based sensors to their ability to detect and resolve features on the Earth's surface.
CLO3 : Describe the spectral and backscatter characteristics of typical materials and objects on the Earth's surface.
CLO4 : Apply image processing and data correction techniques to aid in interpretation of satellite remote sensing images.
CLO5 : Apply supervised and unsupervised classification techniques to distinguish materials and objects in satellite remote sensing images.

Course Learning Outcomes	Assessment Item
CLO1 : Apply Planck's black body radiation law and atmospheric transmission properties to explain how different wavelengths can be used in different types of remote sensing.	• Quiz • Assignment 1
CLO2 : Apply optical theory to relate the design of space-based sensors to their ability to detect and resolve features on the Earth's surface.	• Assignment 3 • Quiz • Assignment 1
CLO3 : Describe the spectral and backscatter characteristics of typical materials and objects on the Earth's surface.	• Assignment 2 • Assignment 3 • Quiz • Assignment 1
CLO4 : Apply image processing and data correction techniques to aid in interpretation of satellite remote sensing images.	• Assignment 2 • Assignment 3 • Assignment 1
CLO5 : Apply supervised and unsupervised classification techniques to distinguish materials and objects in satellite remote sensing images.	• Assignment 2 • Assignment 3

Learning and Teaching Technologies

Moodle - Learning Management System | Blackboard Collaborate

Learning and Teaching in this course

As this course is delivered fully online, a student-centered flipped learning approach is used with Moodle as the core course delivery platform. Each week, students will independently read the listed textbook chapters or websites/articles in the Course Schedule, as well as any other

supplementary course material provided on the Moodle site, and complete the weekly practice quizzes. Although these practice quizzes do not count as part of the final course mark, they serve as an early and continuous indicator of student understanding of course content and provide valuable feedback to students and lecturers.

A one-hour synchronous online video session will be held each week. This video session will include a mini lecture to consolidate important concepts covered in the guided reading for that week, several worked example problems, and an open question and answer period. Any additional course-related questions can be posted in the General Q&A Forum on the course Moodle site, or privately discussed with the course convenor and lecturers. To better accommodate student career and family obligations, a student poll will be taken at the beginning of the course to determine the most convenient video session day/time. All video sessions will be recorded and uploaded to the Moodle site for later asynchronous viewing. Please note that by joining any virtual video session you are giving consent for the session to be recorded.

To help students with time management, the course Moodle site is structured according to weeks aligned with the course schedule, and with specific tasks and activities listed for each week. Additional video sessions may be organised during the course to go through answers to the assessments and/or to provide general feedback if needed.

The Learning Management System

Moodle is the Learning Management System used at UNSW Canberra. All courses have a Moodle site which will become available to students at least one week before the start of semester. Please find all help and documentation (including Blackboard Collaborate) at the Moodle Support page.

UNSW Moodle supports the following web browsers:

» Google Chrome 50+
» Safari 10+
** Internet Explorer is not recommended

** Addons and Toolbars can affect any browser's performance.

Operating systems recommended are:

Windows 7, 10, Mac OSX Sierra, iPad IOS10

For further details about system requirements click here.

Log in to Moodle here.

If you need further assistance with Moodle:

For enrolment and login issues please contact:
IT Service Centre
Email: itservicecentre@unsw.edu.au
Phone: (02) 9385-1333
International: +61 2 9385 1333

For all other Moodle issues please contact:
External TELT Support
Email: externalteltsupport@unsw.edu.au
Phone: (02) 9385-3331
International: +61 2 938 53331

Opening hours:
Monday – Friday 7:30am – 9:30 pm
Saturday & Sunday 8:30 am – 4:30pm

Additional Course Information

Academic Integrity and Plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and students have a responsibility to adhere to this principle of academic integrity. All students are expected to adhere to UNSW's Student Code of Conduct https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Plagiarism undermines academic integrity and is not tolerated at UNSW. *It is defined as using the words or ideas of others and passing them off as your own, and* can take many forms, from deliberate cheating to accidental copying from a source without acknowledgement.

For more information, please refer to the following:

https://student.unsw.edu.au/plagiarism

Referencing

In this course, students are required to reference following the APA 7 / Chicago NB referencing style. Information about referencing styles is available at: https://guides.lib.unsw.adfa.edu.au/c.php?g=472948&p=3246720

Prerequisites

This course assumes that students have at least an undergraduate level of mathematics and physics, and a basic knowledge of the programming language Python. The machine learning and AI content of the course will partially make use of Google Colab (to be introduced during the course), which is an online programming “laboratory” that already includes several machine learning and AI libraries and allows Python code to be run in an internet

Study at UNSW Canberra

https://www.unsw.adfa.edu.au/study

Study at UNSW Canberra has lots of useful information regarding:

- Where to get help
- Administrative matters
- Getting your passwords set up
- How to log on to Moodle
- Accessing the Library and other areas.

Additional Information as required

CRICOS Provider no. 00098G
The University of New South Wales Canberra.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Quiz Assessment Format: Individual	15%	Start Date: 29/07/2024 12:00 AM Due Date: 04/08/2024 11:59 PM Post Date: 29/07/2024 12:00 AM
Assignment 1 Assessment Format: Individual Short Extension: Yes (3 days)	25%	Start Date: Not Applicable Due Date: 23/08/2024 11:59 PM
Assignment 2 Assessment Format: Individual Short Extension: Yes (3 days)	35%	Start Date: Not Applicable Due Date: 04/10/2024 11:59 PM
Assignment 3 Assessment Format: Individual Short Extension: Yes (3 days)	25%	Start Date: Not Applicable Due Date: 25/10/2024 11:59 PM

Assessment Details

Quiz

Assessment Overview

A single main quiz will be conducted before the census date. This quiz will be performed online in the course Moodle site and will consist of several questions that students must answer within a given time limit. The quiz will typically consist of approximately 10 questions that may include multiple-choice questions, sample calculations, and critical analysis of a hypothetical scenario. Answers to quiz questions can be typed into the provided answer boxes or can be uploaded (for example, hand-written calculations or figures).

Course Learning Outcomes

- CLO1 : Apply Planck's black body radiation law and atmospheric transmission properties to explain how different wavelengths can be used in different types of remote sensing.
- CLO2 : Apply optical theory to relate the design of space-based sensors to their ability to detect and resolve features on the Earth's surface.
- CLO3 : Describe the spectral and backscatter characteristics of typical materials and objects on the Earth's surface.

Assessment Length

1 hour

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

Simple Editing Assistance

In completing this assessment, you are permitted to use standard editing and referencing functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other media, whether based on your own work or not.
If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
For more information on Generative AI and permitted use please see here.

Assignment 1

Assessment Overview

The first assignment will consist of a number of questions and scenarios. Assignment questions will evaluate student understanding of fundamental aspects of optical imaging, as well as more in-depth and applied factors such as image correction and interpretation.

Course Learning Outcomes

- CLO1 : Apply Planck's black body radiation law and atmospheric transmission properties to explain how different wavelengths can be used in different types of remote sensing.
- CLO2 : Apply optical theory to relate the design of space-based sensors to their ability to detect and resolve features on the Earth's surface.
- CLO3 : Describe the spectral and backscatter characteristics of typical materials and objects on the Earth's surface.
- CLO4 : Apply image processing and data correction techniques to aid in interpretation of satellite remote sensing images.

Assessment Length

5-10 pages

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Generative AI Permission Level

Simple Editing Assistance

In completing this assessment, you are permitted to use standard editing and referencing

functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other media, whether based on your own work or not.
If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
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Assignment 2

Assessment Overview

This assignment will involve the use of enhancement and classification techniques, including machine learning. Students will be required to answer several questions that will include writing short Python analysis scripts. Students must submit a short document (with proper referencing) of their answers, as well as their Python code. Both the document and code will be submitted via Turnitin. Note that the code provided should correctly run and this will be factored into the assessment grading.

Course Learning Outcomes

- CLO3 : Describe the spectral and backscatter characteristics of typical materials and objects on the Earth's surface.
- CLO4 : Apply image processing and data correction techniques to aid in interpretation of satellite remote sensing images.
- CLO5 : Apply supervised and unsupervised classification techniques to distinguish materials and objects in satellite remote sensing images.

Assessment Length

7.5-15 pages

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Generative AI Permission Level

Simple Editing Assistance

In completing this assessment, you are permitted to use standard editing and referencing functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other

media, whether based on your own work or not.
If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
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Assignment 3

Assessment Overview

The final assignment will consist of a number of questions and scenarios focused on fundamental aspects of radar imaging along with more in-depth and applied factors such as image correction and interpretation.

Course Learning Outcomes

- CLO2 : Apply optical theory to relate the design of space-based sensors to their ability to detect and resolve features on the Earth's surface.
- CLO3 : Describe the spectral and backscatter characteristics of typical materials and objects on the Earth's surface.
- CLO4 : Apply image processing and data correction techniques to aid in interpretation of satellite remote sensing images.
- CLO5 : Apply supervised and unsupervised classification techniques to distinguish materials and objects in satellite remote sensing images.

Assessment Length

5-10 pages

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Generative AI Permission Level

Simple Editing Assistance

In completing this assessment, you are permitted to use standard editing and referencing functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other media, whether based on your own work or not.
If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct &

Integrity Office for investigation for academic misconduct and possible penalties.
For more information on Generative AI and permitted use please see here.

General Assessment Information

All marks obtained for assessment items during the session are provisional. The final mark as published by the university following the assessment review group meeting is *the only official mark*.

Note that all assessments must be completed individually by students (i.e. no group work). Feedback on assessments will be provided within two weeks (10 working days) after the deadline.

Early Feedback

Initial feedback will be provided to students based on the online Quiz they will complete in Week 3. This will provide individual, written feedback on their work prior to the census date (11 August).

Late Submission of Assessment

Unless prior arrangement is made with the lecturer for a short extension or a formal application for special consideration is submitted, a penalty of 5% of the total available mark for the assessment will apply for each day (or part thereof) that an assessment item is late up to a maximum of 5 days (120 hours) after which an assessment can no longer be submitted and a grade of 0 will be applied.

Use of Generative AI in Assessments

For assessment tasks in this course, you may use standard editing and referencing software, but not Generative AI. You are permitted to use the full capabilities of the standard software (such as Microsoft Office or Grammarly) to answer the question. If the use of generative AI such as ChatGPT is detected, it will be regarded as serious academic misconduct and subject to the standard penalties, which may include 00FL, suspension and exclusion.

Grading Basis

Standard

Requirements to pass course

Overall passing mark is set at 50%. Students are not required to pass any one particular

assessment item.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 15 July - 19 July	Lecture	Introduction to Optical Imaging
	Reading	Remote Sensing Digital Image Analysis: • Chapter 1 • Chapter 2 (2.1-2.5) • Appendix A
Week 2 : 22 July - 26 July	Lecture	Distortion and Correction of Optical Images
	Reading	Remote Sensing Digital Image Analysis: Chapter 2 (2.6-2.22)
Week 3 : 29 July - 2 August	Lecture	Radiometric and Geometric Enhancement Techniques
	Reading	Remote Sensing Digital Image Analysis: • Chapter 4 • Chapter 5
	Assessment	Online Quiz (due Sunday, August 4)
Week 4 : 5 August - 9 August	Lecture	Image Interpretation and Supervised Classification
	Reading	Remote Sensing Digital Image Analysis: • Chapter 3 • Chapter 8 (8.1-8.4)
Week 5 : 12 August - 16 August	Lecture	Unsupervised Classification
	Reading	Remote Sensing Digital Image Analysis: • Chapter 8 (8.5-8.16) • Chapter 9 (9.1-9.6)
Week 6 : 19 August - 23 August	Lecture	Introduction to Deep Learning and Neural Networks
	Reading	Deep Learning with Python: • Chapter 1 • Chapter 2
	Assessment	Assignment 1 (due Friday, August 23)
Week 7 : 9 September - 13 September	Lecture	Keras and TensorFlow
	Reading	Deep Learning with Python: • Chapter 3 • Chapter 4
Week 8 : 16 September - 20 September	Lecture	Fundamentals of Machine Learning
	Reading	Deep Learning with Python: Chapter 5
Week 9 : 23 September - 27 September	Lecture	Introduction to Radar Imaging
	Reading	Remote Sensing with Imaging Radar: • Chapter 1 • Chapter 2 (2.1-2.10, 2.16-2.18) • Chapter 3 (3.1-3.4)
Week 10 : 30 September - 4 October	Lecture	Microwave Scattering from Earth Surface Features
	Reading	Remote Sensing with Imaging Radar: • Chapter 3 (3.11-3.15) • Chapter 5
	Assessment	Assignment 2 (due Friday, October 4)
Week 11 : 7 October - 11 October	Lecture	Synthetic Aperture Radar (SAR) and Passive Microwave Imaging
	Reading	Remote Sensing with Imaging Radar: • Chapter 3 (3.5-3.8) • Chapter 6 (6.1-6.4; 6.14.1) • Chapter 9
Week 12 : 14 October - 18 October	Lecture	Distortion and Correction of Radar Images
	Reading	Remote Sensing with Imaging Radar: • Chapter 4 • Appendix D
Week 13 : 21 October - 25 October	Lecture	SAR Image Interpretation
	Reading	Indicated websites/articles on the course Moodle site
	Assessment	Assignment 3 (due Friday, October 25)

Attendance Requirements

Not Applicable - as no class attendance is required

General Schedule Information

Students are strongly encouraged to attend the weekly online lectures or, if unable to do so, to review lecture recordings. Weekly readings from the textbooks are prescribed.

Course Resources

Prescribed Resources

Compulsory Texts:

- Richards, J.A. (2009). Remote Sensing with Imaging Radar. Berlin: Springer.
- Richards, J.A. (2022). Remote Sensing Digital Image Analysis (6th ed.). Berlin: Springer.
- Chollet, F. (2021). Deep Learning with Python (2nd ed.). Shelter Island, NY: Manning.

Recommended Resources

Recommended Readings:

- Schowengerdt, R.A. (2006). Remote Sensing: Models and Methods for Image Processing (3rd ed.). Amsterdam: Elsevier.
- Lillesand, T.M., Kiefer, R.W., & Chipman, J.W. (2015). Remote Sensing and Image Interpretation (7th ed.). Hoboken, NJ: John Wily & Sons.
- Ekman, M. (2022). Learning Deep Learning. Hong Kong: Addision-Wesley.
- Zhang, A., Lipton, Z.C., Li, M., & Smola, A.J. (2023). Dive into Deep Learning. Cambridge: Cambridge University Press.

Course Evaluation and Development

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be asked to complete the myExperience survey towards the end of this course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the “On-going Student Feedback” link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups. Student opinions really do make a difference. Refer to the Moodle site for this course to see how the feedback from previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct Policy:

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Lecturer	George Bo wden		Room 212, Building 16	+61 2 5114 5285	You are welcome to seek consultation during normal working hours. Please email first to make an appointment for an inperson, or virtual meeting. Appointments outside of normal working hours can be made in special circumstances. The email subject line shou	No	Yes
	Sara Salim					No	No