

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

Course Overview

Expected Implementation in Academic Year (New format)	AY2026-2027
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Assoc Prof Benoit Taisne
Course Author Email	btaisne@ntu.edu.sg
Course Title	COMPUTATIONAL EARTH SYSTEMS SCIENCE
Course Code	ES2001
Academic Units	4
Contact Hours	78
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH1801 and MH1800; OR MH1100 and MH1101; OR CY1201 and CY1202; OR CY1602 and CY1601; OR MH1802
Co-requisites	NIL
Pre-requisite to	ES0002, ES2802, ES3006, ES3102, ES4302, ES4902, ES4911
Mutually exclusive to	NIL
Replacement course to	NIL
Remarks (if any)	

Course Aims

In this course, you will learn how to choose data visualization and analysis techniques that are relevant to the scientific challenge you are facing, and to create their own functions for performing these analyses. You will also learn to master a programming language that could serve as a basis to learning other languages. The goal is to give you a solid grounding in the basic statistics and programming techniques that will allow you to continue to build on these skills throughout the rest of your undergraduate training and careers, with a strong emphasis on critical thinking and developing skills that can be adapted in the future to suit a changing world, rapidly changing technologies, and increasingly varied sources of environmental and geoscience data.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Visualise and statistically analyse Earth system and environmental datasets using appropriate computational tools.
ILO 2	Develop and document computer code to read, process, and analyse datasets of varying structure and complexity.
ILO 3	Interpret computational results and communicate findings clearly in written and oral forms.
ILO 4	Demonstrate confidence in computational thinking, problem-solving, and independent learning.

Course Content

The course will cover aspects of programming style and functionality, starting from the basics of variables, loops, reading and plotting external data sets, and writing simple functions. The course will use widely used programming language. Geospatial data and maps will be covered, including the benefits and pitfalls of different map projections and techniques for spatial interpolation of data. We will use time series from environmental data to teach techniques in statistical analysis of time series, such as investigating long-term rates and seasonal cycles. Other classes will ensure that students gain the knowledge and practice to assess the significance of their results, to apply best practices to assess and remove outliers, and to understand and quantify uncertainties in their data and results, as well as to fit simple models to the data.

Reading and References (if applicable)

Weekly reading of documentation on new concept and use of function.

The students are also encourage to read introductory books on environmental data analysis.

The course itself is not following any specific text-book.

Planned Schedule

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
1	Introduction to the class and programming skills	4	In-person	Assignment 1	Varies
2	Reading external file and plotting time series and histograms	1,2,3,4	In-person	Assignment 2	Varies
3	Conditional statements and loops	2; 4	In-person	Assignment 3	Varies
4	Map projection and plotting maps	1,2,4	In-person	Assignment 4	Varies
5	Continue on geospatial representation and tools	1,2,4	In-person	Assignment 5	Varies
6	Catch up week	3,4	In-person	Mid-term 1 / group discussion	Varies
7	Introduction to linear algebra	2,4	In-person	Assignment 6	Varies
8	Data analysis: best fitting	1,2,3,4	In-person	Assignment 7	Varies
9	Data analysis: correlation and cross-correlation	1,2,3,4	In-person	Assignment 8	Varies
10	Data analysis: least squares	1,2,3,4	In-person	Assignment 9	Varies
11	Catch-up week: topic of interest	3,4	In-person	Mid-term 2 / group discussion	Varies
12	Group work: teaching team available to provide guidance	2,4	In-person	Group Discussion	Varies
13	Presentation final projects	1,2,3,4	In-person	Group report and presentation. Individual report	Varies

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Hands-on during lecture	Lecture and tutorial are combine to ensure doing hands-on at the same time as learning a new concept. This is to ensure rapid solidification of the topic and providing immediate opportunity to ask for support if needed
End of the semester project	We will be working towards this early in the semester to ensure that all group are equipped to be successful, from getting access to relevant dataset to producing maps and analysis. The choice of project is completely free, with the only requirement that different dataset and some key analysis can be done.
Report/Presentation	The last week of the semester will be dedicated to presentations, during which each group will present their project to the class. This is an important aspect of the class during which you will demonstrate ability to communicate and collaborate.

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): Test/Quiz(Weekly Quizzes (Open-Book))	2;3;4		10		Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Assignment(Weekly lab assignments)	1;2;3;4		30		Individual	Holistic	Multistructural
3	Continuous Assessment (CA): Test/Quiz(Mid-term tests)	1;2;3;4		30		Individual	Holistic	Relational
4	Continuous Assessment (CA): Report/Case study(Final Project Report (Group + Individual Reflection and peer evaluation))	1;2;3;4	1;2;3;4;5	20		Team	Holistic	Extended Abstract
5	Continuous Assessment (CA): Presentation()	1; 3; 4		10		Team	Holistic	Extended Abstract

Description of Assessment Components (if applicable)

- The weekly assessments are in place to consolidate weekly concept.
- The mid-term would be combining concepts learned to date.
- The final project is there to have the student think out of the box and put together all they've learned in class, and the possibility to include new concept going beyond what they've learn.

Formative Feedback

You will receive verbal feedback from me on weekly quizzes during first contact hour following submission.

You will receive general feedback from the teaching team on weekly assignment during first contact hour following

submission.

You can request for individual feedback during office-hour on top of lecture/lab/tutorial contact time.

Your group will get feedback along the way for your final project.

Feedback on the mid-term will be given upon request the week following the mid-term.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Communication	Intermediate
Digital Fluency	Intermediate
Learning Agility	Intermediate
Problem Solving	Intermediate
Information Literacy	Intermediate

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)

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.

Follow the computer lab rules

These rules are posted in the ASE computer lab to which you have access.

Comment your code

You can never, ever have too many comments in your computer code. Make sure you also take good notes, so that you can come back to your code many years from now and still be able to use it. Also use plenty of whitespace and indentation, so that your code is easy to read.

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. In fact, people with prior experience can gain experience by helping others.

Just make sure that

- (a) You fully understand all your code/calculations by the time you turn it in.
- (b) You acknowledge anyone who helped you.
- (c) You write up your reports and homework assignments by yourself.

Compulsory Assignments

You are required to submit compulsory assignments on due dates through the online system. The latest attempt will be the one graded, score will be considered in the course assessment.

Rules for late submission: You will receive a warning for your first late submission before feedback received. We will then remove 10%; 20%; 30%... for subsequent late submission.

Assignment submitted after feedback are provided will not be graded.

Policy (Absenteeism)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will affect your participation 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. There will be no make-up opportunities for in-class activities, but, pending valid reason, possibility to ask about it during office-hour and following contact hour.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal at ASE 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, a peer or senior, Janelle or Michel (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 an ASE faculty member.

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