Academic Year	19/20	**Semester**	1
Course Coordinator	Asst. Prof. Benoit Taisne		
Course Code	ES2001		
Course Title	Computational Earth Systems Science		
Pre-requisites	MH1802		
No of AUs	4		
Contact Hours	Total hours – 78 (Lecture 26; Tut -13; Lab - 39)		
Proposal Date	5th December 2019		

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 programing 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.

Intended Learning Outcomes (ILO)

By the end of this course, you (as a student) would be able to:

1. Visualize and statistically analyze a range of data sets representative of those found in earth science and environmental fields
2. Develop your own computer code to read and analyse dataset of your choice
3. Interpret and communicate, both orally and in writing, your results
4. Develop your confidence in computational thinking and how this applies to the wider world.

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.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes See appendix 1	Weighting	Team/Individual	Assessment Rubrics
1. Class participation	2; 3; 4	2; 4	10%	Individual	Appendix 2
2. Continuous Assessment (weekly lab assignments)	1; 2; 3; 4	1; 2; 3	50%	Individual	Appendix 3
3. Final project report	1; 2; 3; 4	1; 2; 3; 5	30%	Individual	Appendix 4
4. Final project presentation	1;3;4	1; 2; 3; 4; 6	10%	Team	Appendix 5
Total			100%		

Formative feedback

The class will be given feedback after each weekly assignments. You will receive instant feedback during tutorial and labs. In addition, instructors will be available to answer questions regarding your final project at any time.

Learning and Teaching approach

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

Reading and References

Environmental data analysis with MATLAB, by Menke and Menke, 1st Edition, 2011, Elsevier

Geostatistics explained; An introductory guide for earth scientists, by McKillup and Darby Dyer, 1st Edition, 2010, Cambridge University Press

Course Policies and Student Responsibilities

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.

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.

Follow the computer lab rules

These are posted in the lab. Please note the rules, and know that failure to comply by the rules could result in failure of the class and suspension of other privileges. The rules include bringing no food into the lab. Please also make sure that you turn off the wireless mice after you have finished using the computers.

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 labeled 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 extra credit 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 own reports and homework assigments 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.

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. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Be very careful about plagiarism. There will be heavy penalties for plagiarism of other people's text in your homework and class project, **even if it is by mistake**. Everything must be in your own words, or acknowledged as someone else's by using quotation marks. Paraphrasing other people's text could get you into trouble. Read, think, and then write your text without what you read in front of you.
When it comes to plagiarism and writing computer code there can be a fine line -- we expect that you will look online and in books for examples of good code, and encourage this as a way to learn. However, remember that (a) codes available online are often wrong, and (b) you will not learn by just copying someone else's code. When it comes to writing your own code, to avoid any hint of plagiarism please close any examples of code that are closely related to the problem you are trying to solve.

Course Instructors

Instructor	Office Location	Phone	Email
Benoit Taisne	N2-01b-25	6592-2527	btaisne@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
Week 01	Introduction to the class and programming skills	4	Assignment 1
Week 02	Reading external file and plotting time series and histograms	1; 2; 3; 4	Assignment 2
Week 03	Conditional statements and loops	2; 4	Assignment 3
Week 04	Map projection and plotting maps	1; 2; 4	Assignment 4
Week 05	Continue on geospatial representation and tools	1; 2; 4	Assignment 5
Week 06	Catch-up week	3; 4	Group discussion
Week 07	Introduction to linear algebra	2; 4	Assignment 6
Week 08	Data analysis: best fitting	1; 2; 3; 4	Assignment 7
Week 09	Data analysis: correlation and cross-correlation	1; 2; 3; 4	Assignment 8
Week 10	Data analysis: least squares	1; 2; 3; 4	Assignment 9
Week 11	Catch-up week: topic of interest	3; 4	Group discussion
Week 12	Group work: teaching team available to provide guidance	2; 4	Group discussion
Week 13	Presentation final projects	1; 2; 3; 4	Individual report and group presentation

Appendix 1: ASE Learning Outcomes

At the completion of your course of study in ASE, you will be able to:

1) Demonstrate intellectual flexibility and critical thinking in order to apply environmental knowledge in the real world

2) Communicate environmental concepts with enthusiasm to varied audiences both orally and in writing

3) Formulate scientific questions, and be able to access and analyse quantitative and qualitative information to address them

4) Exhibit the motivation, curiosity and skills for lifelong learning

5) Demonstrate ethical values and responsibility

6) Collaborate and lead by influence

Appendix 2: Class Participation

Standards	**Criteria**
A+ (Exceptional) A (Excellent)	Important contributions to class discussion; ask insightful questions; precisely answer the questions; capacity to articulate and present points of view very clearly; participates in a meaningful and constructive manner including enabling other students to contribute and not dominating; evidence of having read and assimilated class material beyond the assigned reading; strong signs of evidence-based formation of points of view on the topics.
A- (Very good) B+ (Good)	Meaningful contributions to class discussion; ask interesting questions; accurately answer the questions; capacity to articulate and present points of view clearly; participates in a meaningful and constructive manner; evidence of having read and assimilated the class material; some signs of evidence-based formation of points of view on the topics.
B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	Some contributions to class discussion; ask some questions; some capacity to articulate and present points of view; some evidence of constructive engagement during discussion; some familiarity with the assigned reading; some evidence of having thought about controversial topics.
C (Bordering unsatisfactory) C- (Unsatisfactory)	Minimal contributions to class discussion; ask very little questions; can answer a few questions; limited capacity to articulate and present points of view; limited evidence of constructive engagement during discussion; little or no familiarity with the assigned reading; little serious thought about discussion topics.
D, F (Deeply unsatisfactory)	Very minimal or no contributions to class discussion; no questions; could not answer questions; no evidence of an individual viewpoint; failure to read the assigned reading; unexplained or unjustified absences from class activities.

Appendix 3: Weekly Assignment

Standards	Criteria
A+ (Exceptional) A (Excellent)	Takes an original approach to the questions, very well structured and focused, and does not deviate from the given question; evidence of excellent ability to apply knowledge taught in the course while thinking outside the box; evidence of deep understanding and use of programming best practices.
A- (Very good) B+ (Good)	Takes a conventional approach to the question, has evidence of structure and focus, and is mostly on-topic; evidence of some ability to apply knowledge taught in the course; evidence of understanding and use of programming best practices.
B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	Takes a conventional (though somewhat unoriginal) approach to the question, has some evidence of structure and focus, and does not deviate substantially from the topic; evidence of some (but not significant) ability to apply knowledge taught in the course; some evidence of understanding and use of programming best practices.
C (Bordering unsatisfactory) C- (Unsatisfactory)	Does a poor to middling job of addressing the question, has limited structure and focus, and frequently strays off topic; limited evidence of ability to apply knowledge taught in the course; limited evidence of understanding and use of programming best practices.
D, F (Deeply unsatisfactory)	Inadequate in addressing the question, lacks structure and focus, and is mostly or wholly off topic; inadequate capacity to apply knowledge taught in the course; poor understanding and use of programming best practices. OR failure to submit the essay.

Appendix 4: Final project report

- See attached table.

Annex_4_final_report.pdf

Appendix 5: Final project presentation

- See attached table.

Annex_5_final_presentation.pdf

- Please note that teamwork is an important graduate outcome that we wish to inculcate in all students. Therefore, we expect everyone to meaningfully contribute to the presentation. If there is any evidence that you are not contributing to your team's presentation, your individual score may be adjusted.