

<b>Academic Year</b>	2023/2024	<b>Semester</b>	1
<b>Course Coordinator</b>	Sang-Ho Yun		
<b>Course Code</b>	ES3004		
<b>Course Title</b>	Introduction to Geophysics		
<b>Pre-requisites</b>	ES1003 or by permission		
<b>No of AUs</b>	3		
<b>Contact Hours</b>	Lectures 26 hours Tutorial 13 hours Total 39 hours		
<b>Proposal Date</b>	12 June 2023		

### Course Aims

The aim of this course is to learn the physical principles behind various geophysical techniques, to practice how the techniques are applied, and to review and understand the results, through a mixture of lectures and practical examples that students will complete. There are number handling, application of supplied formulae, and quantitative discussion, but it's not a theoretical course: its physics and maths content should be accessible by anyone qualified to join the department. Specific objectives are to introduce the most important methods of geophysics that include active and passive source seismology, gravity, magnetics, geoelectric, electromagnetic, and potential other techniques depending on opportunities. The course will emphasize how to deliver results with topics such as what is a justifiable precision in your quoted results and what is the difference between results and interpretations.

### Intended Learning Outcomes (ILO)

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

1. Identify which technique should be used depending on the question you have to answer
2. Evaluate the quality of the data you collected or were given to analyse
3. Make sound interpretations of your data
4. Communicate, both orally and in writing, your results

### Course Content

The course will cover ranges of geophysical technics used to image and infer underground properties or processes. The course will give the students the tools and confidence to critically assess the value of a given technique to answer a given question. Through the combined use of seismology, gravity, magnetic, and electric surveys, they will derive a view of what lies under their feet. They will have a physical sense of the relation between wave frequency and their ability to image given size anomaly, for given property contrast. Wherever possible, the course will engage data collection in the field, within Singapore, to give the students direct, hands-on experience. When this is not possible or applicable we will use real-world data for classes and labs. They will be exposed to real-world example and industrial standard.

**Assessment (includes both continuous and summative assessment)**

Component	ILO Tested	Related program LO or Graduate Attributes (Appendix 1)	Weighting	Team/Individual	Assessment Rubrics
1. Practical Exercises	1,2,3	1,2,3	50%	Individual	Appendix 2
2. Continuous Assessment (short online quizzes)	1,2,3	1,3	20%	Individual	Appendix 3
3. Final Project Report	1,2,3,4	1,2,3,4,5,6	15%	Team	Appendix 4
4. Final Project Presentation	1,2,3,4	1,2,3,4,5,6	15%	Team	Appendix 5
Total			100%		

**Group formation**

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

**Formative feedback**

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

**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 teamwork opportunities.

**Reading and References**

Recommended reading for this class: "Introduction to Applied geophysics", H. Robert Burger (Author, Smith College), Craig H. Jones (Author, University of Colorado at Boulder), Anne F. Sheehan (Author, University of Colorado at Boulder), ISBN: 978-0-393-92637-8

## Course Policies and Student Responsibilities

### (1) General

You are expected to complete all assigned pre-class readings and activities, attend all lecture classes punctually and take all scheduled tests by due dates. You are expected to take responsibility to follow up with course notes and course related announcements for seminar sessions they have missed. You are expected to participate in all seminar discussions and activities.

### (2) Missed Assessments

When you are absent from an assessment due to illness, you must submit a medical certificate within 7 working days. A student who is absent from assessment without valid Leave of Absence will be given zero mark for the missed assessment. Course lecturers may, however, use their own discretion for extenuating circumstances. Policy on medical leave for student may be found at <http://www.ntu.edu.sg/Students/Undergraduate/AdminServices/Pages/Applyforshortleave.aspx>.

### (3) Special Accommodations

All courses will have some form of assessment and if you envision that you will have difficulty satisfying an assessment component due to your disability then you are advised to contact the Course Coordinator within the first 2 weeks of the course.

Students requiring assistance in the learning environment should contact and notify the Associate Chair (Academic) in their School within the first 2 weeks of their first semester so that you and School can work together to optimise your learning experience. Examples of services that may be provided or supported in individual courses include an editor service to help those with reading and writing difficulties, and access to a personal mentor within the School.

Please access the NTU Office of Academic Services' website

<http://www.ntu.edu.sg/sasd/oas/Pages/default.aspx> for more information about the arrangements for candidates during examinations.

### (4) ASE 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 thoughts, perspectives, and experiences, and that honours your identities (including ethnicity race, gender, socioeconomic status class, sexual orientation, religion or, ability., etc.).

To help accomplish this:

- If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come and talk with one of the instructors or an ASE faculty member. We want to be a resource for you.
- Your classmates and instructors (like many people) are still in the process of learning about diverse perspectives and identities. If something was said in class (by anyone) that made you feel uncomfortable, please talk to the instructors or an ASE faculty member about it.
- As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: (e.g., 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., etc.).

We expect all members of the class to adhere to the NTU Anti-harassment policy

(<https://ts.ntu.edu.sg/sites/policyportal/new/Documents/msrf%20included%20NIE%20staff/Anti-Harassment%20Policy.pdf>), if you witness something that goes against this or have any other concerns, please speak to your instructors or an ASE faculty member.

## 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.

## Course Instructors

Instructors	Office Location	Email
Sang-Ho Yun	N2-01a-09b	sangho.yun@ntu.edu.sg
Karen Helen Lythgoe	N2-01a-14	karen.lythgoe@ntu.edu.sg
Hongyu Zeng (TA)	N2-01a-14b (Office Hours: Tue 3-5pm)	hongyu002@e.ntu.edu.sg
Benoit Taisne (Honorary)	N2-01b-25	BTaisne@ntu.edu.sg

## Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction to the class. Introduction to seismic	1	
2	Global seismology: from earthquakes to imaging	1; 2; 3	Quiz on global seismology
3	Seismic exploration, part 1. Guest lecture by Charles Elachi.	1; 2; 3	
4	Seismic exploration, part 2	1; 2; 3	Quiz on seismic exploration. Tutorial on seismics
5	Gravity methods	1; 2; 3	Practical and Quiz on Gravity
6	Magnetic methods, part 1	1; 2; 3	Field demo
7	Magnetic methods, part 2	1; 2; 3	Tutorial on Magnetic
8	Geoelectrical methods	1; 2; 3	Tutorial on Geoelectrical and field demo
9	Field deployment	1; 2; 3	Practical on previous weeks
10	Field deployment	1; 2; 3	
11	Interpretation of field data and catch-up on previous concepts	1; 2; 3	

12	Geophysics in your backyard: Singapore underground and geophysical networks	1; 2; 3	Potential for site visit
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: Practical Exercises

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.
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### Appendix 3: Continuous Assessments

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 rubrics

- See attached table.

### Appendix 5: Final project presentation rubrics

- See attached table.
- 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.
- The peer evaluation constitutes 30% of your final score for the team project and presentation.
- Please rate the contribution for each of your team members. If you believe some of your team members contributed less than they should, please detail the issues and provide sufficient evidence to support your claim.

Criteria	Yourself	Member 1	Member 2	Member 3	Member 4	Member 5
<b>Contributed the fair share of work</b> (Score: 0 to 10)						
TOTAL						
Comments, if any						