Academic Year	AY2017/18	**Semester**	2
Course Coordinator	Asst. Professor Shengji WEI		
Course Code	ES4911		
Course Title	Seismology		
Pre-requisites	MH1800 Calculus for the Sciences I OR MH1802 Calculus for the Sciences, ES2001 Computational Earth Systems Science, PH1801 Foundation of Physics I & MH1200 Linear Algebra		
No of AUs	3		
Contact Hours	Total hours – 39 (Lecture – 20; class activities – 19)		
Proposal Date	Semester 2 AY17-18		

Course Aims

This is an advanced seismology course, and as such it builds on the foundations and theory that you, the student, will have been exposed to in geophysical courses. Because it is an advanced course, the aim is to get you to think critically and to apply your knowledge to new and unfamiliar situations, rather than just memorize facts. As such, you will be introduced to a series of fundamental seismological topics including (1) basic concepts in seismology (2) seismic waves and synthetic seismograms, (3), seismic tomography (4) seismic source theory and (5) Retrieval of Seismic Source Parameters. A large part of the course will also be doing a class project on a topic in seismology.

Intended Learning Outcomes (ILO)

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

1. Illustrate theoretical knowledge of key concepts in the general area of seismology
2. Apply seismological concepts to unfamiliar situations
3. Critically assess start-of-art topics in seismology that are currently under development
4. Conduct seismological data processing independently and present the results convincingly in both written and oral form

Course Content

The Seismology class includes introduction to the principles of modern seismology and the practical applications of a series of tools to improve the understanding of the earth structure and the tectonic processes that can produce seismic signal, such as earthquakes. The class will cover (1) basic concepts in seismology; (2) seismic waves and synthetic seismograms; (3) seismic tomography; (4) seismic source theory and (5) retrieval of seismic source parameters.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment Rubrics
1. Class participation	1,2,3	Knowledge, Intellectual flexibility and critical thinking, problem solving, passion and communication	20%	Individual	Appendix 1
2. Preparation and presentation of class project	1,2,3,4	Intellectual flexibility and critical thinking, formulating questions, passion and communication	50%	Individual	Appendix 2
3. Homework*	1,2,3,4	Knowledge, Intellectual flexibility and critical thinking, formulating questions	30%	Individual	Appendix 3
Total			100%		

***Note:**
1. The homework is designed to enhance the understanding of the content taught in lectures and to also improve the practical skills for the students. Most of the homework will be conducted on the computers (e.g. through coding).

2. Students will be assessed by the accuracy of their answers to the questions. Students are encourage to solve the problems with new approach that are not taught in class.

Formative feedback

You will receive oral feedback for Component 1, written feedback for Component 3, and either written or oral feedback as appropriate for the various parts of Component 2

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	To effectively convey information on fundamental theories and key concepts and to bring all students up to similar levels of knowledge (LO1)
Interactive activities	Various activities (homework, tutorial, class projects, in class discussion, etc) to help students analyze and deepen your understanding of the concept and sharpen your skills to solve the practical problems (LO2, LO3, LO4)

Reading and References

This is course aims to encourage you to think critically, and solve practical problems with a series of tools. The following books will be used as the main references/textbooks:

1. Lay, T., and T. C. Wallace, Modern Global Seismology, Academic Press, San Diego, 1-517, 1995, ISBN-13: 978-0127328706

2. Bullen, K. E., and B. A. Bolt, An Introduction to the Theory of Seismology, 4 edition, Press Syndicate of the University of Cambridge, Cambridge, 1-499, 1985, ISBN-13: 978-0521283892

3. Udias, Agustin, Principles of Seismology, Cambridge University Press, Cambridge, 1-475, 1999, ISBN-13: 978-0521624787

Course Policies and Student Responsibilities

(1) General

Students are expected to complete all assigned pre-class readings and activities on time, attend all lectures, tutorial and class discussions, and submit 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 for seminar sessions they have missed.

(2) Absenteeism

Absence from scheduled lectures and discussion without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate.
If you miss a lecture or tutorial exercise you must inform me via email (shjwei@ntu.edu.sg) prior to the start of the class.

(3) Compulsory Assignments

You are required to submit compulsory assignments on due dates, unless a valid reason is provided. Valid reasons include falling sick supported by a medical certificate. If you will miss a deadline for a valid reason you must inform me via email (shjwei@ntu.edu.sg) prior to the deadline, and as soon as is possible.

Academic Integrity

Good academic work depends on honesty and ethical behavior. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honor 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

Instructor	Office Location	Phone	Email
Shengji WEI	N2-01a-06	6592-7743	shjwei@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Instructor	Course LO	Readings/ Activities	
1 (Jan 14-19)	Introduction	S.W.	1,2,3	Read pre-class materials.	
2 (Jan 22-26)	Basic Concepts in Seismology (Structure, Ray Theory)	S.W.	1,2,3,4	"	
3 (Jan 29 – Feb 2)	Basic Concepts in Seismology (Locating Earthquake, Seismicity)	S.W.	1,2,3,4	"	
4 (Feb 5-9)	Seismic Waves and Synthetic Seismogram (Wave Equation)	S.W.	1,2,3,4	"	
5 (Feb 12-16)	Seismic Waves and Synthetic Seismogram (Generalized Ray Theory)	S.W.	1,2,3,4	"	
6 (Feb 19-23)	Seismic Waves and Synthetic Seismogram (Surface Waves and Normal Mode)	S.W.	1,2,3,4		
7 (Feb 26 – Mar 1)	Tomography (Travel Time and Waveform Tomography)	S.W.	1,2,3,4	"	
8 (Mar 11-15)	Tomography (Receiver Functions)	S.W.	1,2,3,4	"	
9 (Mar 18-22)	Seismic Source Theory (Static Source)	S.W.			
10 (Mar 26-29)	Seismic Source Theory (Elastodynamic Source)	S.W.	1,2,3,4	"	
11 (Apr 1-6)	Retrieval of Seismic Source Parameters and Plate Tectonics	S.W.	1,2,3,4	"	
12 (Apr 8-12)	Class Project	S.W.	1,2,3,4	"	
13 (Apr 15-19)	SYNTHESIS, PRESENTATIONS	S.W.	1,2,3,4	"	

Appendix 1: Assessment Criteria for Participation and Class Discussion

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 2: Assessment Criteria for Preparation and Presentation of Class Project

Standards	Criteria
A+ (Exceptional) A (Excellent)	Clear description, interpretation and explanation of research process and findings Clarity and distinct originality of thought, with clear link to major topics from research materials, as well as important linked topics. Correct use of referencing throughout. Use of stylish scientific language, with no grammatical or spelling errors. Write the code clearly and independently. Shows clear understanding of key concepts and theories, and interpretation of wider context issues. Formatted in the correct scientific specification.
A- (Very good) B+ (Good)	Clear description and explanation of research process and findings Clarity of thought, with clear link to major topics from research materials Correct use of referencing throughout. Write the code independently. Use of scientific language, with few grammatical and no spelling errors. Shows an understanding of secondary readings/research

	Shows an understanding of the key concepts and theories. Formatted to the correct scientific specification.
B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	Some description and explanation of research process and findings. Some discernable links to the major topics from research materials. Correct use of referencing throughout most of the paper. Write the code with some help from TA or instructor. Fair use of scientific language, with some grammatical and spelling errors. Shows a fair understanding of secondary readings/research Shows some understanding of the key concepts and theories. Formatted to the correct scientific specification.
C (Bordering unsatisfactory) C- (Unsatisfactory)	Some description of research process and findings. Limited link to major topics from research materials. Correct use of referencing throughout some of the paper. Write the code with lots of help from TA and instructor. Some use of scientific language, with grammatical and spelling errors. Identifies secondary readings/research Identities key concepts and theories. Some attempt to format to the correct scientific specification.
D (Deeply unsatisfactory) F (0-44)	Unclear or no description of research process and findings Failure to link to major topics from research materials Incorrect use of referencing throughout most of the paper. No scientific language, with grammatical and spelling errors. No secondary readings/research referenced. Can not write the code. No identification or misinterpretation of key concepts and theories. Incorrect formatting. Or Failure to submit project report

Appendix 3: Homework Assignments

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 not just memorization of key concepts taught in the course.
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; some evidence of understanding and not just memorization of key concepts taught in the course.

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 familiarization of key concepts taught in the course but evidence of deep understanding is limited.
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 familiarization of key concepts taught in the course.
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 familiarization of key concepts taught in the course. OR failure to submit the essay.