COURSE OUTLINE: ES4904

Course Title	**Volcanology**		
Course Code	**ES4904**		
Offered	Study Year 3, Sem 2 | Study Year 4, Sem 2		
Course Coordinators	Caroline Bouvet de la Maisonneuve (Asst Prof)	CarolineBouvet@ntu.edu.sg	6592 7826
	Fidel Costa (Assoc Prof)	fcosta@ntu.edu.sg	6592 2401
	Benoit Taisne (Asst Prof)	Btaisne@ntu.edu.sg	6592 2527
	Susanna Jenkins (Asst Prof)	susanna.jenkins@ntu.edu.sg	6592 7753
Pre-requisites	ES1003;ES2002;ES3003;ES3004		
AU	3		
Contact hours	Lectures: 26, Laboratories: 13		
Approved for delivery from	AY 2018/19 semester 2		
Last revised	12 Mar 2019, 14:58		

Course Aims

You will learn the foundations of volcanology as a science, will discover the state-of-the-art tools that are available for research, and will apply and therefore build a new set of skills related to these tools.

Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

1. Better appraise the scale of volcanic eruptions and their underlying mechanisms
2. Link and integrate various sources/types of information (e.g. petrologic, field, monitoring, modelling data)
3. Use standard volcanological techniques to analyse natural datasets
4. Recognize challenges in forecasting volcanic eruptions and their impacts

Course Content

Magmatic petrology applied to volcanology

Volcano geophysics

Physical volcanology

Volcanic hazards and risks

Assessment

Component	Course ILOs tested	ASE Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Laboratories					
In-class participation in the form of quizzes and in-class activities	1, 2, 3, 4	**1.** a, b **2.** a, b **4.** a, b **8.** a, b **10.** a, b	20	individual	See Appendix for rubric
Volcano Petrology Assessment	1, 2, 3, 4	**1.** a, b **2.** a, b **4.** a, b **5.** a, b, c **8.** a, b **9.** a, b, c **10.** a, b	20	both	See Appendix for rubric
Volcano Geophysics Assessment	1, 2, 3, 4	**1.** a, b **2.** a, b **4.** a, b **8.** a, b **10.** a, b	20	team	See Appendix for rubric
Physical Volcanology Assignment	1, 2, 3, 4	**1.** a, b **2.** a, b **4.** a, b **5.** a, b, c **8.** a, b **10.** a, b	20	team	See Appendix for rubric
Volcanic Hazards and Risks Assessment	1, 2, 3, 4	**1.** a, b **2.** a, b **4.** a, b **8.** a, b **9.** a, b, c	20	individual	See Appendix for rubric
		Total	**100%**		

These are the relevant ASE Graduate Attributes.

1. Apply environmental knowledge, concepts and skills to make sound decisions

a. Interpret evidence to give sound environmental advice to stakeholders

b. Give advice to industry regarding existing environmental legislation

2. Demonstrate intellectual flexibility and critical thinking

a. Demonstrate intellectual flexibility to view environmental issues from multiple perspectives

b. Question assumptions behind current ways of solving environmental problems

4. Formulate key scientific questions and develop hypotheses

a. Research and formulate questions involving environmental issues

b. Create and evaluate hypotheses to research such questions

5. Conduct research

a. Search for relevant scientific literature

b. Synthesize findings from scientific literature into laboratory reports, presentations, written assignments and field reports

c. Make first-hand observations in order to draw conclusions

8. Demonstrate the willingness and skills for lifelong learning

a. Demonstrate aptitude and enthusiasm to learn independently

b. Demonstrate good observation skills and a curiosity about the world

9. Demonstrate ethical values

a. Debate the ethical implications of scientific processes and results

b. Respect regulations involving plagiarism and copyright

c. Respect requirements regarding confidentiality, data protection, conflict of interest, and falsification of data

10. Demonstrate collaboration and leadership skills

a. Learn collaboratively and be willing to share expertise with peers

b. Demonstrate leadership of small teams

Formative Feedback

Formative feedback will be provided:

Component 1: Instantly through quiz scores and through active discussions.
Components 2-5: within 2 weeks of the assignment submission / test date.

General feedback will be given on request as part of the end of course review.

Learning and Teaching Approach

Lectures (26 hours)	Lectures will pass on the theoretical knowledge required to understand the different components of the Volcanic system and the related scientific methods employed to investigate and monitor it.
Laboratories (13 hours)	The labs will be based on real world practical problems and will challenge students to research outside of the classroom to solve the issues faced in the labs. Students will have the opportunity to use some of the state of the art equipment available and will write synthetic reports of their findings.

Reading and References

There is no standard textbook or references for this course. Specific readings or references will be given during class.

Course Policies and Student Responsibilities

As a student of the course, you are required to abide by both the University Code of Conduct and the Student Code of Conduct. The Codes provide information on the responsibilities of all NTU students, as well as examples of misconduct and details about how students can report suspected misconduct.

The University also has the Student Mental Health Policy. The Policy states the University's commitment to providing a supportive environment for the holistic development of students, including the improvement of your mental health and wellbeing. These policies and codes concerning students can be found in the following link:

http://www.ntu.edu.sg/SAO/Pages/Policies-concerning-students.aspx

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

Instructor	Office Location	Phone	Email
Caroline Bouvet de la Maisonneuve (Asst Prof)	N2-01B-27	6592 7826	CarolineBouvet@ntu.edu.sg
Fidel Costa (Assoc Prof)	N2-01b-24	6592 2401	fcosta@ntu.edu.sg
Susanna Jenkins (Asst Prof)	N2 01b-23	6592 7753	susanna.jenkins@ntu.edu.sg
Benoit Taisne (Asst Prof)	N2-01b-25	6592 2527	Btaisne@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Introduction	1	
2	Building of magma reservoirs	1, 2, 3, 4	Introduction to thermodynamics
3	Volcano plumbing systems	1, 2, 3, 4	Geothermobarometers applied to magmatic systems
4	Magmatic petrology applied to volcanology	1, 2, 3, 4	Geospeedometers applied to volcanic systems
5	Volcano seismology	1, 2, 3, 4	Identifying different type of events and give basic interpretation
6	Volcano geodesy and infrasound	1, 2, 3, 4	Extracting source information and characteristic based on GPS and InSAR
7	Looking at volcano monitoring data all together	1, 2, 3, 4	Running real-time scenario combining different type of data
8	Physical properties of magmas	1, 2, 3, 4	Calculations of magma densities and viscosities
9	Bubble nucleation and growth, and eruptions	1, 2, 3, 4	Measurements of sample porosities and permeabilities
10	Eruptive deposits	1, 2, 3, 4	Investigating eruption styles based on magma properties and physical processes
11	Source reconstruction from deposits	1, 2, 3, 4	Estimating eruption source parameters from available field data

12	Hazard modelling	1, 2, 3, 4	Numerical modelling of one or more volcanic hazards
13	Volcanic risk and impacts	1, 2, 3, 4	Understanding how volcanic hazards affect society, and how we calculate risk.

Appendix 1: Assessment Rubrics

Rubric for Laboratories: In-class participation in the form of quizzes and in-class activities (20%)

Marks	**Criteria**
> 90%	Participated in >90% of the in-class quizzes and gave >90% of correct answers; Contributed weekly to the class discussions with relevant and well-articulated comments such as critical evaluations of data and research papers.
75% to 89%	Participated in >75% of the in-class quizzes and gave 75-89% of correct answers; Contributed almost weekly to the class discussions with relevant questions and comments such as evaluations data and research papers.
65% to 74%	Participated in >65% of the in-class quizzes and gave 65-74% of correct answers; Contributed to more than half of the class discussions with questions and some relevant comments.
50% to 64%	Participated in >50% of the in-class quizzes and gave 50-64% of correct answers; Contributed to less than half of the class discussions with questions mainly.
< 50%	Participated in <50% of the in-class quizzes and/or gave <50% of correct answers; Did not or rarely contributed to the class discussions.

Rubric for Laboratories: Volcano Petrology Assessment (20%)

Individual or in pairs depending on class size This assessment involves the collection and interpretation of a small dataset, summarized in a short report.

Grade / Numerical Score	Criteria
A+ (Exceptional) A (Excellent)	- Clarity and distinct originality of thought, with clear link to major topics from both class and from further research. - Correct use of referencing throughout. - Use of stylish scientific language, with no grammatical or spelling errors. - Ability to introduce, review and engage critically with secondary readings (where relevant) - Shows clear understanding of key concepts and theories, and interpretation of wider context issues. - Formatted in the correct scientific specification.
A- (Very good)	- Clarity of thought, with clear link to major topics from class. - Correct use of referencing throughout. - 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+ (Good) B (Average)	- Some discernable links to the major topics from class. - Correct use of referencing throughout most of the paper. - 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.
B- (Satisfactory) C+ (Marginally satisfactory) C (Bordering unsatisfactory)	- Limited link to major topics from class. - Correct use of referencing throughout some of the paper. - 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.
C- (Unsatisfactory) D (Deeply unsatisfactory)	- Failure to link to major topics from class. - Incorrect use of referencing throughout most of the paper. - No scientific language, with grammatical and spelling errors. - No secondary readings/research referenced. - No identification or misinterpretation of key concepts and theories. - Incorrect formatting.
F (0-44)	Failure to submit final report

Rubric for Laboratories: Volcano Geophysics Assessment (20%)

Groups of 3-5 students depending on class size This assessment involves volcano forecasting from a real-time scenario, with a final report summarizing the rationale for decisions made.

Grade / Numerical Score	Criteria
A+ (Exceptional) A (Excellent)	- Clarity and distinct originality of thought, with clear link to major topics from both class and from further research. - Correct use of referencing throughout. - Use of stylish scientific language, with no grammatical or spelling errors. - Ability to introduce, review and engage critically with secondary readings (where relevant) - Shows clear understanding of key concepts and theories, and interpretation of wider context issues. - Formatted in the correct scientific specification.
A- (Very good)	- Clarity of thought, with clear link to major topics from class. - Correct use of referencing throughout. - 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+ (Good) B (Average)	- Some discernable links to the major topics from class. - Correct use of referencing throughout most of the paper. - 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.
B- (Satisfactory) C+ (Marginally satisfactory) C (Bordering unsatisfactory)	- Limited link to major topics from class. - Correct use of referencing throughout some of the paper. - 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.
C- (Unsatisfactory) D (Deeply unsatisfactory)	- Failure to link to major topics from class. - Incorrect use of referencing throughout most of the paper. - No scientific language, with grammatical and spelling errors. - No secondary readings/research referenced. - No identification or misinterpretation of key concepts and theories. - Incorrect formatting.
F (0-44)	Failure to submit final report

Rubric for Laboratories: Physical Volcanology Assignment (20%)

A short, scientific paper-like report synthesizing measurement and readings done in pairs.

Grade / Numerical Score	Criteria
A+ (Exceptional) A (Excellent)	- Clarity and distinct originality of thought, with clear link to major topics from both the recommended text and from further research. - Correct use of referencing throughout. - Use of stylish scientific language, with no grammatical or spelling errors. - Ability to introduce, review and engage critically with secondary readings (where relevant) - Shows clear understanding of key concepts and theories, and interpretation of wider context issues. - Formatted in the correct scientific specification. - Clear, well-formatted figures, properly referenced in the text. - Valid dataset with mention of uncertainties.
A- (Very good)	- Clarity of thought, with clear link to major topics from the recommended text. - Correct use of referencing throughout. - 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. - Clear, well-formatted figures. - Valid dataset with mention of uncertainties.
B+ (Good) B (Average)	- Some discernable links to the major topics from the recommended texts - Correct use of referencing throughout most of the paper. - 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. - Relevant figures, although clarity could be improved. - Valid dataset but no mention of uncertainties.
B- (Satisfactory) C+ (Marginally satisfactory) C (Bordering unsatisfactory)	- Limited link to major topics from the recommended text. - Correct use of referencing throughout some of the paper. - 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. - Few figures, which clarity needs to be improved. - Partial dataset which requires description.
C- (Unsatisfactory) D (Deeply unsatisfactory)	- Failure to link to major topics from the recommended text. - Incorrect use of referencing throughout most of the paper. - No scientific language, with grammatical and spelling errors. - No secondary readings/research referenced. - No identification or misinterpretation of key concepts and theories. - Incorrect formatting. - Insufficient figures and data.
F (0-44)	Failure to submit final report

Rubric for Laboratories: Volcanic Hazards and Risks Assessment (20%)

One MCQ during final lab session.