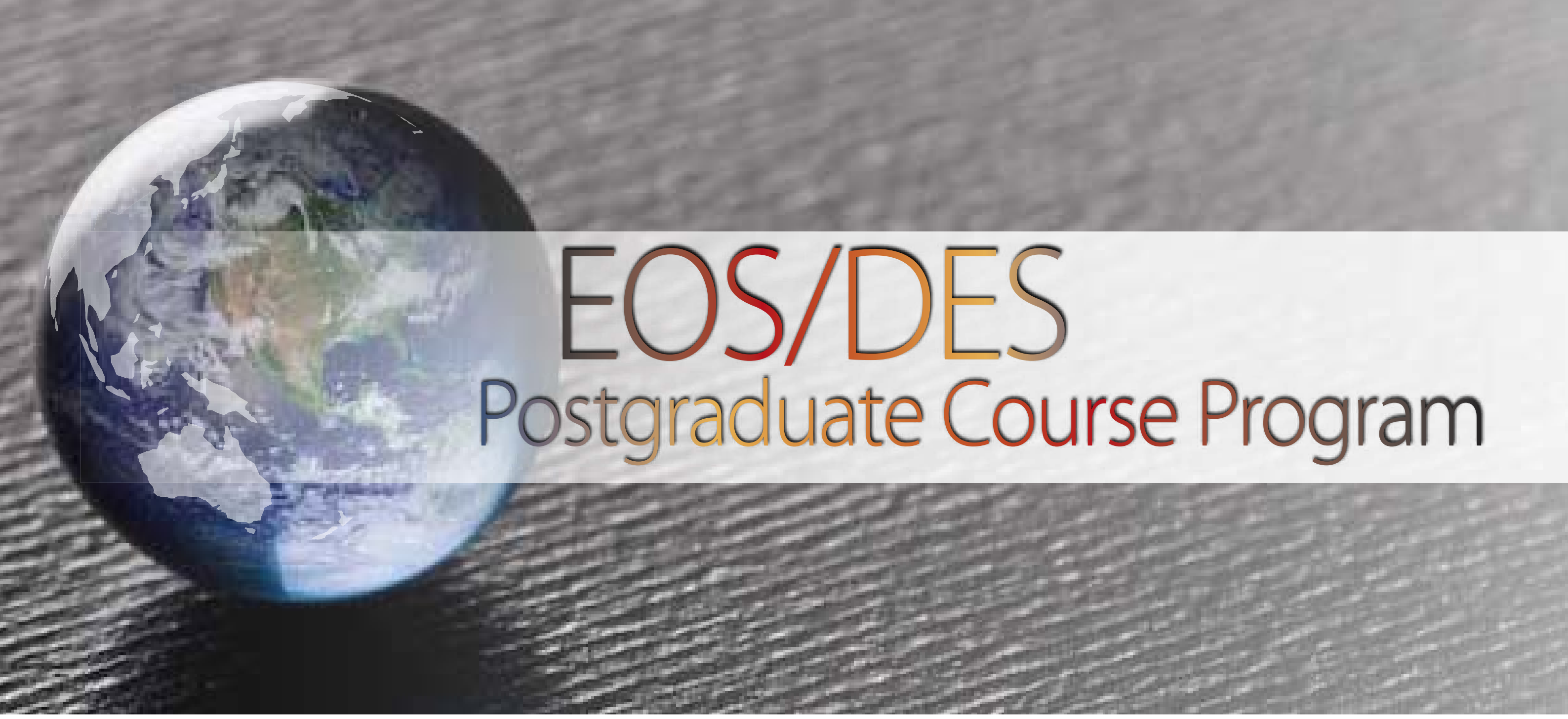

EOS/DES
Postgraduate Course Program

Post-graduate courses will include these required courses:

- Natural hazards and society
- EOS Seminar
- Reviews of special topics in earth sciences
- Field studies

Initial elective post-graduate courses will be:

- Foundations of earth sciences
- Tectonics and seismotectonics
- Volcanic processes
- Hazardous coasts
- Understanding climate change
- Paleoseismology and paleogeodesy
- Advanced analytical techniques for the earth sciences
- Paleoclimatology

All courses are 3AU

EARTH OBSERVATORY OF SINGAPORE
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Descriptions Of Initial Required Courses

Natural Hazards And Society

This course examines the natural and human dimensions of hazards such as earthquakes, tsunamis, tropical storms, floods, landslides, soil erosion and desertification.

Course work focuses on the causes of major natural hazards -- such as climate change, sea-level rise, and tectonics – as well as their spatial and temporal distribution.

Moreover, students will be exposed to the assessment of risks posed to society and possibilities for sustainable adaptation.

Learning Outcomes	Assessment
At the end of this course the students should be able to: • describe natural hazards (using examples) and explain why they occur when and where they do • describe the effects of natural hazards on human lives, property and livelihoods; • demonstrate a basic comprehension of how risks from natural hazards are assessed and can be managed and how our attitudes and actions can influence the impact of natural hazards	Tests/projects 30% Final Examination 70%

EOS Seminar

Weekly seminars will provide exposure to a broad range of research in the earth sciences. Speakers will be from the Earth Observatory of Singapore, other academic groups at NTU, and other universities and research institutes.

Students in this course are required to attend 8 seminars and to submit reports on 3 of the seminars, summarizing the work, methods and conclusions presented. After each of their chosen 8 seminars, students must also participate in a discussion session, led by a faculty member of DES/EOS, on the material that was presented in the seminar. Each report will be graded by the student's research advisor (or by another DES faculty member agreed upon by the student's research advisor).

Learning Outcomes	Assessment
At the end of this course a student should be able to: • engage in substantial scientific discussions with EOS, DES, and visiting scientists • evaluate critically the academic value of an earth-science presentation, and what techniques and skills made it understandable and effective (or not!). • seek out scientific viewpoints that contrast with the speaker's, and critically compare those contrasting views	Attendance 10% Seminar reports 30% Oral presentation 60%

Reviews Of Special Topics In Earth Sciences

Keeping abreast of important advances in science requires not only keen research skills and avid study but also the ability to identify the published wheat from the chaff.

This course will introduce students to important new literature and at the same time teach them to effectively identify important new work through a series of reviewing exercises that teach critical and efficient analysis of material in mainstream media, grey-media and peer-reviewed journals. To aid in the development of their own writing skills, students will also be asked to examine critically the writing styles exemplified in the reviewed materials.

This course requires a student to investigate and review the current state of knowledge of a field in their area of specialization. Students are encouraged to use this opportunity to develop a strong background in their research field and to produce a review paper.

Learning Outcomes	Assessment
At the end of this course the students should: • be able to critically review, critique and summarise a variety of scientific publications, with respect to both their content and their effectiveness. • have a broader knowledge of current issues	Outline report 30% Review paper 70%

Field Studies

Graduate students in DES must participate in at least two field campaigns with a DES faculty member, regardless of their specialization. The student will assist in planning for the field trip, collect samples, make geological maps and sketches and keep a detailed record of observations and interpretations.

A scientific report, written upon completion of the field trip, will describe the scientific purpose and outcome of the campaign.

Learning Outcomes	Assessment
At the end of this course the students should be able to: • plan and then conduct a field campaign • demonstrate data collection and analysis skills, including sampling, mapping and note-taking	100% field report

Descriptions Of Initial Elective Courses

Foundations Of Earth Science

This course aims to ensure that graduate students in DES and EOS have fundamental knowledge of the earth sciences. Students without such a basic background will be encouraged to take this course.

Topics covered include: early earth, earth structure, earth materials, tectonics, earth resources, earth system science, and surface processes.

Learning Outcomes	Assessment
At the end of this course a student should be able to: • describe, explain and connect the basic principles, concepts, and theories of the earth sciences using appropriate scientific language. • describe, communicate and explain how the earth sciences are relevant to everyday life and to the advancement of civilization.	Laboratory and mapping exercises 25% Essay 25% Practical exam 25% Final examination: 25%

Tectonics And Seismotectonics

This course investigates the processes at work in the main tectonic environments of our planet (rifts and ridges, subduction zones, collisional mountain- and plateau-building, and strike-slip faults). Physical mechanisms of deformation are introduced, based on theoretical and experimental rock mechanics, and it is shown how they operate in integrated fashion over a wide range of spatial and time scales (from crystals to plates, and from millions of years to seconds).

Examples will be drawn from the most typical and best understood regions of the world, with a strong emphasis on eastern Asia. The emphasis will also be placed on active faulting and tectonics, to throw light on the processes through which faults generate earthquakes, and on what can be learnt about crustal structure and rheology from earthquakes.

Large-scale deformation models will be discussed. The course includes a field trip to one outstanding region of Asia or the world (for example, the Himalayan MFT in Nepal, Ailao Shan Shear zone in Yunnan, Assal Rift in Djibouti).

Learning Outcomes	Assessment
At the end of this course the students should be able to: • understand and draw active structures of all kinds, and how they function and grow • know the basic rules of kinematics • understand the fundamental physical processes that govern rock deformation at different scales in the brittle and plastic fields	Tests/projects 20% Final Examination 80%

Volcanic Processes

Course content and assessment to be confirmed.

Advanced Analytical Techniques For The Earth Sciences

Course content and assessment to be confirmed.

Hazardous Coasts

No coast is immune from the potential impact of sea-level rise, tsunami or storms. Coastal populations are increasing at unprecedented rates leaving millions of people at risk of coastal hazards such as tsunami and storms.

This course provides students with an overview of the interdisciplinary science behind the study of sea level change, tsunami and storms.

Topics include ice-ocean-land interactions, relative sea level change, tsunami generation and propagation, storm dynamics, coastal geomorphology, palaeoevent analysis and the social impacts of oceanic hazards.

Several Asia-Pacific case studies are included including the 2004 Indian Ocean tsunami, Cyclone Nargis and the 2009 Samoan tsunami.

Learning Outcomes	Assessment
At the end of this course the students should be able to: • describe the history, dynamics and drivers of global sea level change with appropriate scientific language • indentify and describe the generating mechanisms of tsunamis and storm surges • define and provide examples of the impacts storms and tsunami events have in coastal settings • describe how palaeoevent analysis is used to assist in defining the recurrence interval of storms and tsunami.	Class exercises 30% Case study 20% Final examination 50%

Understanding Climate Change

This course introduces the student to Earth's climate system and its components.

The course divides into three roughly equal parts: Part I -- conceptual foundations, including radiative transfer in the atmosphere and geophysical fluid dynamics; Part II – application of these concepts to explain the observed atmosphere and ocean, including their dynamic and thermal structure, the importance of moist convection and conservation of angular momentum in maintenance of the tropical Hadley cell circulation;

Part III – synthesis of these and numerical modeling to understand aspects of global climate change, including natural versus anthropogenic variability, inter-annual and inter-decadal patterns such as the ENSO, IOD, PDO and NAO.

Learning Outcomes

At the end of this course the students should be able to:

- understand and explain the physical basis of the greenhouse effect
- understand the basic dynamics and thermodynamics of the atmosphere and oceans
- apply the above to explain the structure of the Earth's atmosphere and oceans
- appreciate the interaction between the various components of the climate system, especially through the water cycle
- give examples of natural climate variability
- discuss the problem of global climate change as a result of anthropogenic emissions of greenhouse gases
- appreciate the impacts of climate change on the environment and society
- understand the physical and mathematical basis of climate prediction models

Assessment

Tests/projects 40%
Final Examination 60%

Paleoseismology And Paleogeodesy

Earthquakes can be better forecasted and modern tectonic deformation better understood if the record of prior earthquakes and deformation is known.

This course introduces the use of geological strata and landforms to decipher records of past tectonic deformations associated with the earthquake cycle and explores related fundamental questions in earthquake science.

Illustrative examples will be drawn from a variety of geologic environments, including coastal marine, deep-sea, fluvial, glacial and lacustrine. Problem sets and laboratory exercises will train students in the use of paleoseismological and paleogeodetic methods.

Learning Outcomes

At the end of this course the students should
- understand the basic scientific problems that have been and that remain to be addressed by study of the earthquake record
- critically evaluate relevant literature
- solve simple paleoseismic and paleogeodetic problems in the field

Assessment

Project 25%
Labs 25%
Field trip 25%
Final Examination 25%

Paleoclimatology

Course content and assessment to be confirmed

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