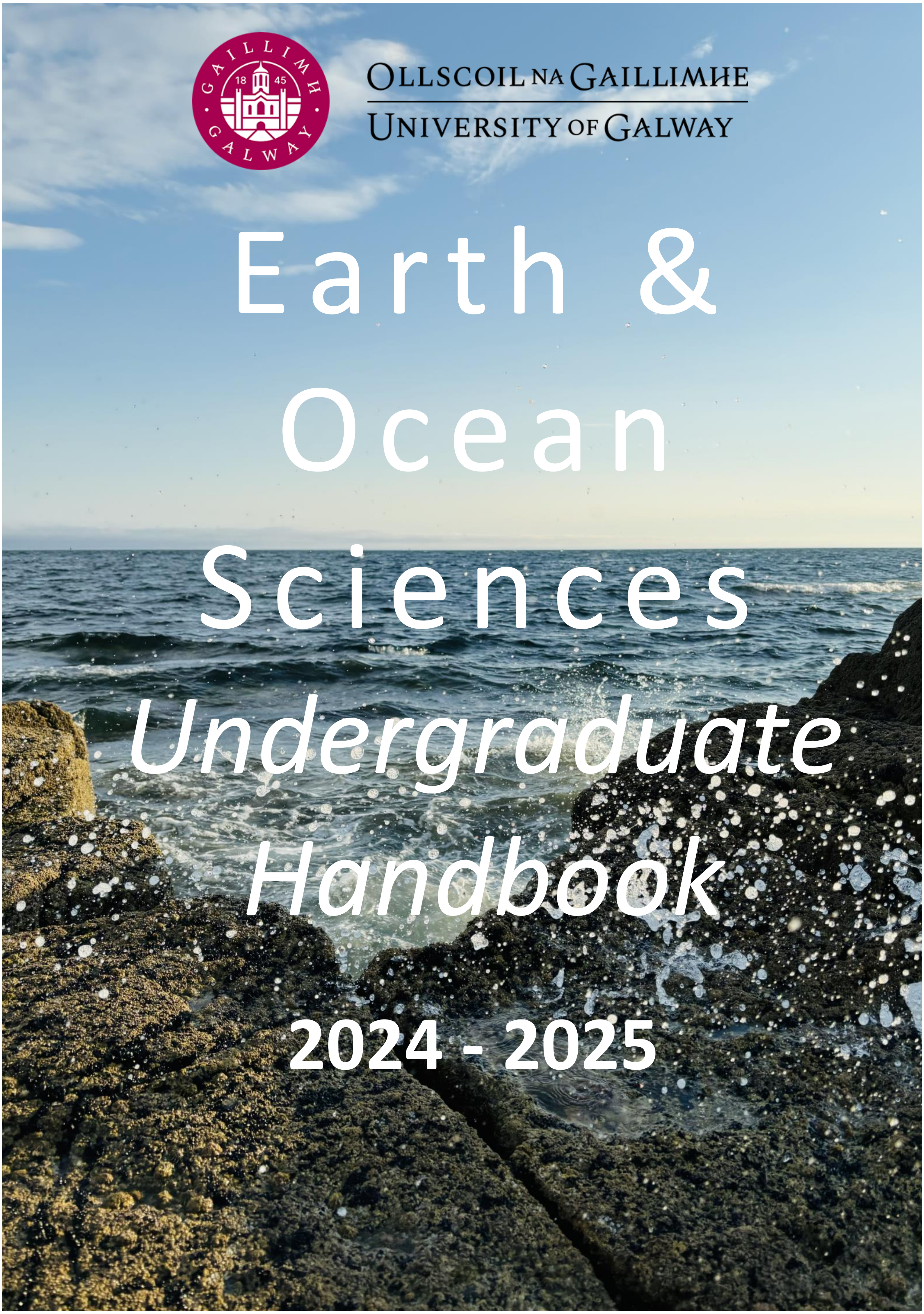

Ollscoil na Gaillimhe
University of Galway

Earth & Ocean Sciences

Undergraduate Handbook

2024 - 2025

Welcome to Earth and Ocean Sciences (EOS)

It is a real pleasure to welcome you all back to EOS, or to welcome you to EOS if you are a new arrival to the University of Galway.

The great societal challenges of this century, and many of the UN Sustainable Development Goals, are directly related to earth and ocean science: increasing vulnerability to geological hazards (floods, earthquakes); increasing need for renewable energy to replace oil and gas and to capture and store anthropogenic carbon; increasing demand for rare minerals and metals to support modern technology; and increasing need to sustainably manage all water resources as our climate changes. How do we rise to these challenges and how can we plan against their impacts? EOS is perfectly placed to train you as a geoscientist equipped with the academic, technical and field skills required to better understand both the complex processes of planet Earth and our interactions with them.

At the University of Galway, we offer an approach to Earth and Ocean Sciences that is unique in Ireland. Our staff's expertise covers a wide range of disciplines such as mineralogy, petrology, geochemistry, geophysics, hydrogeology, physical and chemical oceanography, marine biogeochemistry, palaeobiology and sedimentology. Whether we are studying earthquakes, plate tectonics, volcanoes, ocean productivity, ocean currents, mass extinctions, climate change, natural resources, energy, or environmental pollution, the most productive insights into these phenomena often arise from interactions amongst the different disciplines.

We hope you will find the Earth and Ocean Sciences programme at Galway a lively, interesting, challenging, engaging and friendly environment. If you have any difficulties, if you have any questions, if you're not sure how to find someone or where to find an office, please remember that there are plenty of people – in EOS, Student Services and the College of Science & Engineering - who are here to help you. Don't hesitate to ask.

Dr Eve Daly

Head of Earth & Ocean Sciences

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Section 1: Contacts and Communications

Where to find EOS

The main EOS offices for academic staff, the EOS administrator Lorna Larkin and the A206 classroom are in the south wing of the Quadrangle (*see white circle in picture below*).

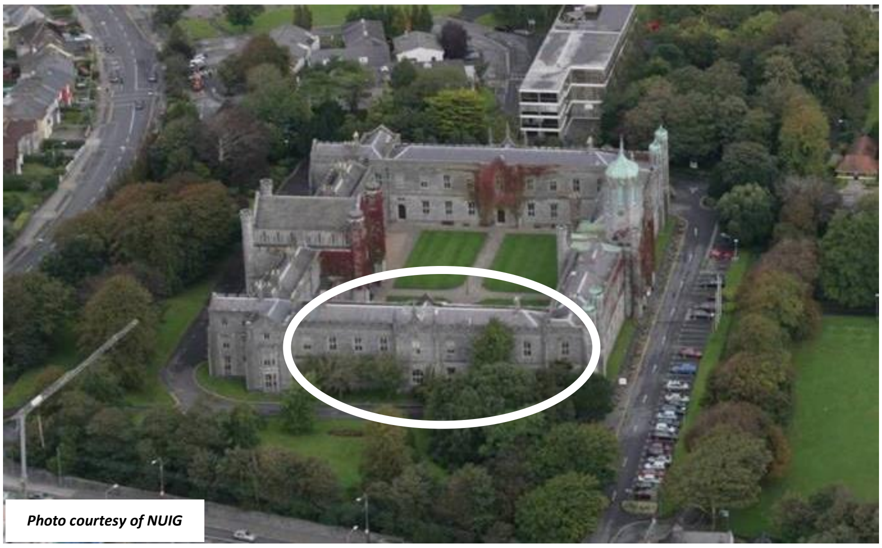

Photo courtesy of NUIG

Technical and research staff are housed in the Ryan Institute and Orbsen Building on campus. The teaching room in the Quadrangle (A206) is used mainly for Third and Fourth Year classes. Larger First and Second year classes use a range of venues across the campus.

EOS general contact details:

Earth & Ocean Sciences
School of Natural Sciences
University of Galway
Galway H91 TK33
IRELAND

Phone: +353 (0)91 492126
EMAIL: lorna.larkin@universityofgalway.ie
WEB: www.universityofgalway.ie/eos/

EOS Staff List & Contact Details

www.universityofgalway.ie/science-engineering/school-of-natural-sciences/disciplines/earth-ocean-science/

Academic Staff	***Office***	***Phone***	***Email***
Dr Eve Daly (***Head of EOS***)	A104a Quad	2310	eve.daly@universityofgalway.ie
Dr Sadhbh Baxter	A104 Quad	5962	sadhbh.baxter@universityofgalway.ie
Dr Jake Ciborowski	A203a Quad	3069	jake.ciborowski@universityofgalway.ie
Prof Peter Croot	A207b Quad	2194	peter.croot@universityofgalway.ie
Dr Anthony Grehan	A107 Quad	3235	anthony.grehan@universityofgalway.ie
Dr Tiernan Henry	A205 Quad	5096	tiernan.henry@universityofgalway.ie
Prof Mark Johnson	Ryan Institute	5864	mark.johnson@universityofgalway.ie
Dr Liam Morrison	Ryan Institute	3200	liam.morrison@universityofgalway.ie
Dr John Murray	A209 Quad	5095	john.murray@universityofgalway.ie
Dr Shane Tyrrell	A204 Quad	4387	shane.tyrrell@universityofgalway.ie
Dr Martin White	A206 Quad	3214	martin.white@universityofgalway.ie
Research Staff	***Office***	***Phone***	***Email***
Ms Avery Fenton	Ryan Institute	3197	avery.fenton@universityofgalway.ie
Mr Oisín Leonard	Ryan Institute		oisín.leonard@universityofgalway.ie
Dr Oisín Callery	200 Quad	5157	oisin.callery@universityofgalway.ie
Dr Hannah Lehnhart-Barnett	A105 Quad		hannah.lehnhart-barnett@universityofgalway.ie

EOS Staff List & Contact Details

Administrative & Technical Staff	***Office***	***Phone***	***Email***
Ms Lorna Larkin (*Administrator*)	A208a Quad	2126	lorna.larkin@universityofgalway.ie
Mr Shane Rooney (*Chief Technician*)	Ryan Institute	2310	shane.rooney@universityofgalway.ie
Dr Alessandra Costanzo	206/7 Orbsen	2129	alessandra.costanzo@universityofgalway.ie
Ms Aedín McAleer	Ryan Institute	3921	aedin.mcaleer@universityofgalway.ie

Office Hours & Appointments

If you wish to talk to staff members please feel free to do so during practicals, labs and seminars. *It is advisable to e-mail the relevant member of staff if you would like a face to face meeting outside the classroom or laboratory to ensure staff are available*.

Contacts for Enquiries

If you have any enquiries relating to a specific course, in the first instance email the relevant lecturer or course convenor (*see pp. 12 & 13*). If you have any concerns about a course or your degree or life in Galway you should contact the Programme Director of EOS (Dr Eve Daly) or Lorna Larkin (*EOS Administrator*). If they cannot help you directly, they will refer you to someone who can.

E-mail/Canvas

Please remember to check your University of Galway e-mail regularly. *All EOS courses are on Canvas and all registered student email addresses are assigned to the relevant courses*. Specific information (lecture slides, handouts, papers, assignments, notices, etc.) on each course will be posted on the relevant Canvas page so check these regularly. Announcements made via Canvas will be sent to your university email address.

Check the EOS website (www.universityofgalway.ie/eos) for updates and for more details on staff, ongoing research etc.

Log on to Canvas regularly for information, updates and notices regarding specific courses.

You need to check your University of Galway email account regularly for announcements and notices, and also delete old emails regularly so your quota is not exceeded. If you miss an important announcement because your inbox was too full, or you failed to check it, the responsibility is yours.

Please note: **with the change to the Canvas virtual learning environment there is also a change in the language used to describe the elements of your degree programme. Your programme each year comprises a total of 60 ECTS of *courses.* Each course is worth 5, 10 or, more rarely, 20 ECTS. The term *module* is still used, but only to describe smaller components of individual courses.**

Academic Terms Dates 2024 - 2025

Semester One (2nd, 3rd & 4th Year students) **(2024)**	
Start	Monday 9th September
End	Friday 29th November
Semester One (1st Year Students)	
Start	Monday 16th September
End	Friday 29th November
Semester One Exams ALL YEARS	*Monday 9th December – Friday 20th December*

Semester Two *(All Years)* **(2025)**	
Start	Monday 13th January
End	Friday 4th April
Fieldtrips	Friday 4th April – Friday 11th April

Semester Two Exams	Tuesday 22nd April - Friday 9th May
Autumn Repeat Exams	Tuesday 5th August – Friday 15th August

All Academic Term dates can be found here:
www.universityofgalway.ie/registry/academic-term-dates/

Section Two: The Earth & Ocean Science Degree

Aims and objectives

Higher education is about teaching *and* learning: this is much more a collaborative process than in secondary education. You will be taught in many ways – in large and small classes, in groups, individually, in laboratories and practicals, and, in our case, in the field. In this coming academic year, the bulk of the teaching and learning will be on campus, with all lecture notes and supporting material available online; the level of *your* engagement will be especially important for your success in the process. We will be there to help and to guide your learning, but as you progress from first to final year you will take more control of your learning.

We aim to provide you with a supportive environment in which you can successfully pursue your degree and develop your academic, vocational, personal and interpersonal skills. By the time you graduate you will have been exposed to the major contemporary academic, practical and societal questions within the geosciences.

Your objective should be to achieve a fundamental but rigorous grounding in EOS. In addition to these intellectual objectives, you should also be developing your academic, personal and interpersonal skills throughout your undergraduate career. These will help you to succeed in achieving the intellectual objectives to the best of your abilities and prepare you for your career after graduation.

Residential & Day Field Work & Field Trips in EOS

We are planning a series of one-day field trips for Second Year Denominated EOS and Environmental Science (EV) students, one residential field trip for Third Year Denominated EOS students (and any undenominated students intending to complete fourth year in EOS), and one residential field course for Fourth Year EOS students. The Second Year day trips and the Third Year residential trip will be run during designated field study week at the end of Semester 2.

A number of one-day field trips will also be run aligned with specific courses. Individual lecturers will provide information on those in class and on the relevant Canvas page.

The **financial costs charged to students for each fieldtrip** will vary depending on trip duration, number of students and accommodation availability. These costs must be paid in advance, before departure. EOS will always endeavour to keep these costs for students as **low as possible** (for example each trip is typically self-catering).

The cost for each of the residential trips is usually around €250 per student.

Note: *If you are in receipt of a student grant, you may be able to apply to SUSI* (https://susi.ie/) *for assistance towards fieldtrip costs as they are a compulsory requirement for your degree programme.*

First Year	EOS students take 60 ECTS of **Biology, Chemistry, Maths** & **Physics. You will learn to apply and combine these fundamental sciences in the study of the earth and oceans in subsequent years**
Second Year	Denominated EOS students take all 25 ECTS of EOS courses on offer. Non-EOS students hoping to complete their degree in EOS must take the 20 ECTS of EOS core courses. Core for EOS & non-EOS students: • **EOS213** *Introduction to Oceanography* (10 ECTS) • **EOS2102** *The Earth: From Core to Crust* (10 ECTS) Core/compulsory for Denominated EOS and Environmental Science (EV) students *only*: • **EOS2101** *Introduction to Fieldskills* (5 ECTS)
Third Year	Denominated EOS students automatically take 50 ECTS of core EOS courses. Non-EOS students planning to finish their degree in EOS in fourth year must take *a minimum of 40 ECTS of EOS* courses, including **EOS3101** & **EOS3104** (*see below*). ***We strongly recommended that they take all 50 ECTS of EOS courses on offer as this keeps all options open in final year.*** Core for *all* students who meet the criteria above: • **EOS3101** *Geological Structures & Maps* (5 ECTS) • **EOS3104** *Fieldskills Training* (5 ECTS) For EOS & non-EOS students: • **EOS303** *Ocean Dynamics* (5 ECTS) • **EOS304** *Aquatic Geochemistry* (5 ECTS) • **EOS305** *Introduction to Applied Field Hydrology* (5 ECTS) • **EOS323** *Sediments and the Sedimentary Record* (5 ECTS) • **EOS3102** *Environmental & Marine Geophysical Remote Sensing* (5 ECTS) • **EOS3103** *Palaeontology & Evolution* (5 ECTS) • **EOS3107** Minerals, magmas, and metamorphism (10 ECTS) For undenominated students hoping to take **EOS and Zoology or EOS and Botany** in third year there is a special combination of courses in both subjects which must be taken (to keep them open as viable pathways). Please **contact the third year coordinator (Dr John Murray: john.murray@universityofgalway.ie) for more information**.

Fourth Year	***65*** *ECTS of final year EOS courses are available: students must take a minimum* ***55*** *ECTS of these, but are* ***strongly encouraged*** *to take* ***60 ECTS*** *of EOS in final year as it will be more beneficial for your academic CV.*
	Core: • **EOS4103** *Advanced Fieldskills* (5 ECTS), and, • **EOS402** *Global Change* (5 ECTS), and, • **EOS403** *Final Year Project* (20 ECTS) **or** • **EOS4102** *Minor Project* (10 ECTS) *Allocation of Final Year Projects or Minor Projects is based on overall third year grades and class ranking.*
	The core courses above account for either 20 or 30 ECTS. Students then select from the following 5 ECTS EOS courses. • A minimum of 55 ECTS of EOS courses is needed in 4th year to complete your degree in EOS. Students are stongly encouraged take 60 ECTS of EOS courses in their final year • **EOS405** *Field Skills in Oceanography* • **EOS407** *History of Life* • **EOS409** *Biophysical Interactions in the Oceans* • **EOS418** *Applied Field Hydrogeology* • **EOS422** *Sedimentary Basins* • **EOS4101** *Earth Observation & Remote sensing* • **EOS4105** *Economic Geology: Principles, Practice & Sustainability*

EOS Year Coordinators:

The course coordinators for each year are:

First Year: Dr Martin White (martin.white@universityofgalway.ie)

Second Year: Dr Shane Tyrrell (shane.tyrrell@universityofgalway.ie)

Third Year: Dr John Murray (john.murray@universityofgalway.ie)

Fourth Year: Dr Anthony Grehan (anthony.grehan@universityofgalway.ie)

Section 3: EOS Course Details

Year	Code	ECTS	Course Title	Convenor
2	***EOS213***	10	Introduction to Oceanography	Martin White
	EOS2101	5	Introduction to Field Skills	Sadhbh Baxter
	EOS2102	10	The Earth: From Core to Crust	Shane Tyrrell
3	***EOS303***	5	Ocean Dynamics	Martin White
	EOS304	5	Aquatic Geochemistry	Peter Croot
	EOS305	5	Applied Field Hydrology	Tiernan Henry
	EOS323	5	Sediments & the Sedimentary Record	Shane Tyrrell
	EOS3101	5	Geological Structures & Maps	Jake Ciborowski
	EOS3102	5	Environmental & Remote Sensing	Eve Daly
	EOS3103	5	Palaeontology and Evolution	John Murray
	EOS3104	5	Fieldskills Training	John Murray
	EOS3107	10	Minerals, magmas and Metamorphism	Sadhbh Baxter
4	***EOS403***	20	Final Year Project	Eve Daly
	EOS4102	10	Minor Project	Tiernan Henry
	EOS4103	5	Advanced Fieldskills	Jake Ciborowski
	EOS4101	5	Earth Observation and Remote Sensing	Eve Daly
	EOS402	5	Global Change	Peter Croot
	EOS405	5	Fieldskills in Oceanography	Anthony Grehan
	EOS407	5	History of Life	John Murray
	EOS409	5	Biophysical Interactions in the Ocean	Martin White
	EOS418	5	Applied Field Hydrogeology	Tiernan Henry
	EOS422	5	Sedimentary basins	Shane Tyrrell
	EOS4105	5	Economic Geology: Principles, Practice and Sustainability	Jake Ciborowski

Semester One 2024-2025

***All* EOS lecture materials and supporting materials will be available on each course Canvas page.**

Second Year	EOS213 *Introduction to Oceanography*	Semester 1 Weeks 1-12 10 ECTS

Aims:
This course will cover fundamental interactions between the oceans, atmosphere and the seafloor. Students will study how physical, chemical, biological and geological properties and processes shape the ocean we have today, and the key role of the oceans in Earth's climate.

Course Convenor: ***Martin White*** Lecturers: ***Martin White***

Format & Duration:
36 lectures, 20 hours of practicals in MRI Annexe lab on Tuesday afternoons plus 2 short fieldwork sessions planned for week 4 & 5. 12 weeks duration.

Assessment:
Two-hour theory examination (50%), report on instruments (5%) practical handbook + examinable questions (25%), two-hour practical exam (15%), multiple answer quizzes (10%).

On successful completion of the course, students will be able to:
- Explain the processes that exchange energy and water within the Earth system
- Describe the main sources, sinks and pathways of material in the oceans
- Explain how the temperature, salinity and density structure in the ocean arises and be able to distinguish different water masses on a T-S diagram
- Explain how waves and tides are generated in the oceans and how these generate currents
- Recognise the difference between Eulerian and Lagrangian co-ordinate systems and measurement techniques and be able to represent them graphically
- Describe the process of hydrothermal circulation of seawater through the seabed and resulting transformations in the chemistry of seawater
- Describe the biogeochemical cycling of O_2, CO_2 and nutrients in the oceans
- Discuss the formation and global distribution of biogenic marine sediments
- Carry out calculations of volume transport and fluxes of material in the oceans
- Grasp the breadth of instrumentation used in oceanography and understand how a subset of these work and how they are used in oceanographic research

Recommended Reading:
- Stewart, R.H. (2014) *Introduction to Physical Oceanography* (Texas A&M University) The online version of this textbook is provided free and will be available on Canvas
- Libes, S.M. (2009) *Introduction to Marine Biogeochemistry 2nd Ed.* Elsevier
- Chester, R.C. & Jickells, T.D. (2012) *Marine Geochemistry 3rd Ed.* Wiley Blackwell

Prerequisite Course: None

Target Groups:
- *Compulsory* for EOS and Marine Science students
- *Strongly recommended* for Physics, Chemistry, Zoology and Botany students

Third Year	**EOS305** ***Introduction to Applied Field Hydrology***	**Semester 1 Weeks 1-6 5 ECTS**

Aims: Hydrology is the term that broadly describes the study of water on, in and above the Earth's surface. This course is designed to introduce students to the theories and concepts underpinning the discipline and to allow them to learn how to measure, estimate and calculate river and groundwater flows in the field and in the lab.

Course Convenor: ***Tiernan Henry*** Lecturer: ***Tiernan Henry***

Format & Duration: 24 lectures; five practical assignments.

Assessment: Two-hour theory examination (70%) and continuous assessment (30%): 20% for practical work, 10% for online quizzes.

Structure:
- Properties of fluids (and water)
- Surface hydrological processes
- Catchments
- Groundwater

On successful completion of the course, students will:
- Have an appreciation of the nature of the relationships between water and the land
- Be able to complete water balances at local and regional scales
- Know where and how to source data and information to prepare and produce water balances and water audits at various scales
- Be able to compare and differentiate between methods for *measuring*, *estimating* and *calculating* hydrological data sets
- Be able to assess past hydrological events and future (predicted) events and contextualise these into return intervals
- Be able to incorporate field data, published data and interpreted data to make reasonable inferences about water and the land

Recommended Reading:
- Brassington, R. (2017) *Field Hydrogeology 4th Ed*. Wiley, London
- Fetter, C.W. (2001) *Applied Hydrogeology 4th Ed*. Prentice Hall, New York
- Shaw, E.M., Beven, K.J., Chappell, N.A. & Lamb, R. (2011) *Hydrology in Practice, 4th Ed*. Spon Press, London
- Chadwick, A., Morfett, J. & Borthwick, M. (2004) *Hydraulics in Civil & Environmental Engineering, 4th Ed*. Spon Press, London

Prerequisite Course: EOS2102 *The Earth: From Core to Crust*

Target Groups: Highly recommended for EOS and undenominated science students who wish to take EOS in fourth year.

Third Year	EOS323 *Sediments & the Sedimentary Record*	Semester 1 Weeks 7-12 5 ECTS

Aims: This course will take a detailed look at the characteristics of clastic, chemical, biogenic and volcaniclastic sediments and sedimentary rocks. Students will investigate how the sediments and rocks originate, learn about the range of depositional environments in which they accumulate and/or form, and examine their potential importance as an economic resource.

Course Convenor: ***Shane Tyrrell*** Lecturer: ***Shane Tyrrell***

Format & Duration: 18 lectures and five 2-hour practical sessions.

Assessment: One two-hour theory examination (70%) and continuous assessment/practicals (30%)

Structure:
- Classification of sedimentary rocks
- The origin of limestones and carbonate reefs
- Volcaniclastic sediments
- Fluid mechanics and the formation of sedimentary structures
- Depositional environments through geological time
- Deltas, estuarine and shallow marine environments
- Fluvial systems and architecture
- Deep marine sedimentation

On successful completion of the course, students will be able to:
- Interpret a range of sedimentary structures
- Describe the principles behind basic fluid mechanics
- Link sedimentary rock composition to ancient environments
- Interpret simple geochemical analyses of sedimentary rocks
- Reconstruct ancient depositional environments from observations and interpretations

Recommended Reading:
- Stow, D.A.V. (2005) *Sedimentary rocks in the field: a colour guide*
- Nichols, G. (2009) *Sedimentology and stratigraphy*
- M.E. Tucker (1981) *Sedimentary petrology*
- Collinson, J., Thompson, D.B. & Mountney, N. (2005) *Sedimentary structures*
- Leeder, M.R. (2010) *Sedimentology and sedimentary basins*

Prerequisite Course: EOS2102 *The Earth: From Core to Crust*

Target Groups: Compulsory for EOS students. Recommended for Marine Science and undenominated students

Third Year	EOS3103 *Palaeontology & Evolution*	Semester 1 Weeks 1-6 5 ECTS

Aims: This course will introduce students to palaeontology (the study of fossils). All of the major animal groups, who have left their mark in the fossil record, will be examined, along with trace fossils. Emphasis will be placed firmly on understanding form and function in organisms and how it has related to their habitat over time. The course will finish with the topic of vertebrate evolution.

Students will be trained to think both logically and critically; they will be shown how to develop arguments and answer questions based on the data available to them (or indeed collected by them in class). The background theme of the entire course will be to provide students with an appreciation for the story of evolution of life on Earth over the past c.539 million years.

Course Convenor: ***John Murray*** Lecturer: ***John Murray***

Format & Duration: 24 lectures and five 2-hour practicals.

Assessment: Two-hour theory exam (70%) and assessment of practical work (30%)

On successful completion of the course, students will:

- Label and describe the basic body plans of a wide range of invertebrate and vertebrate (fossil and living) groups
- Explain some of the physical principles governing the body construction of organisms
- Recognise the link between form and function in organisms and to then apply that insight to understanding how various creatures interact with their physical living environments (both at present and also in the past)
- Identify trace fossils and interpret their palaeoecological significance
- Describe and appraise the history of life on planet earth
- Collect, record and appraise scientific data
- Apply biological data/information not just qualitatively, but also quantitatively

Recommended Reading:

- Benton, M.J. & Harper, D.A.T. (2020) *Introduction to Paleobiology and the Fossil Record (Second Edition),* Wiley-Blackwell
- Wyse Jackson, P.N. (2019) *Introducing Palaeontology: A guide to ancient life (Second Edition),* Dunedin

Prerequisite Course: EOS2102 *The Earth: From Core to Crust*.

Co-requisite Course: EOS323 *Sediments & The Sedimentary Record*.

Target Groups:
Core for denominated EOS students (3EH2), optional for Marine Science (3MR2), Undenominated Science (3BS9) and Environmental Science (3EV2) students.

Third Year	EOS3107 *Minerals, magmas, and metamorphism*	Semester 1 Weeks 1-12 10 ECTS

Aims: Igneous and metamorphic rocks make up the vast bulk of the Earth's crust. These rocks can tell us about past plate tectonic settings; can help assign absolute dates to the geological time scale; and, in many cases, are the source region or host of economically valuable mineral resources. This course will look at the description and interpretation of these rocks, and how we can use them to Earth's history.

Course Convenor: ***Sadhbh Baxter*** Lecturer: ***Sadhbh Baxter***

Format & Duration: 24 hours lectures, 24 hours online & practical work, 24 hours lab work.

Assessment: Two-hour theory exam (50%); continuous assessment (50%)

Structure: The course will start with an introduction to the use of the petrographic microscopes. The *tools of the trade* (interpretation of geochemistry, mineralogy, and textures) will be covered. The *big picture* context is next: the plate tectonic settings. We will look at the creation of oceanic crust at mid-ocean ridges (MOR), melt production, and hydrothermal alteration processes. The final part focuses on subduction zones: metamorphism of subducting oceanic lithosphere, generation of magma, and creation of new continental crust.

On successful completion of the course, students will be able to:

- Recognise, record, and identify the optical properties of minerals: relief, pleochroism, interference colours, and extinction
- Describe the main igneous & metamorphic rocks (in hand specimen and thin section*)
- Identify the main igneous & metamorphic rocks (in hand specimen and thin section)
- Interpret the main igneous & metamorphic rocks (in hand specimen and thin section)
- Describe how the chemistry & mineralogy of an igneous rock are linked to magmatic processes
- Describe how the chemistry of the protolith & the agents of metamorphism determine the mineralogy of the resultant metamorphic rock
- Classify global igneous & metamorphic processes & products (including mineralisation) and their links with plate tectonics

*hand specimens & thin sections of rocks will include virtual models & real samples.

Recommended Reading:

- Perkins, D. & Henke, K.R. (2003) *Minerals in Thin Section*, Pearson
- MacKenzie, W.S., Adams, A.E. & Brodie, K.H. (2016) *Rocks & Minerals in Thin Section 2nd Ed.,* CRC Press
- Deer, W.A., Howie, R.A. & Zussman, J. (2013) *An introduction to the rock-forming minerals 3rd Ed.,* Mineralogical Society
- Best, M.G. (2002) *Igneous & metamorphic petrology*, Wiley

Prerequisite Course: EOS2102 *The Earth: From Core to Crust*
Target Groups: Core for EOS (3EH2) students, optional for others with prerequisite

Fourth Year	EOS402 *Global Change*	Semester 1 Weeks 7-12 5 ECTS

Aims: This course introduces students to multi-disciplinary studies of the physical forcings and earth/ocean system responses that induce and drive environmental change on different temporal and spatial scales. Emphasis is placed on understanding and communicating the basic science behind natural climate cycling (e.g. Milankovitch/ENSO) and more recent anthropogenic forcings (e.g. fossil fuel burning, agricultural practices).

Course Convenor: ***Peter Croot*** Lecturer: ***Peter Croot***

Format & Duration: 24 lectures, two x 2 hours per week (*in person where practical, lecture materials available online*). In this course the continuous assessment consists of a weekly exercise (on Canvas) involving the processing and interpretation of climate related data.

Assessment: Two-hour theory examination (70%) and continuous assessment (30%)

Structure: Students will be introduced to multi-disciplinary studies of the physical forcings and earth/ocean system responses inducing and driving environmental change on different temporal and spatial scales. Emphasis is on understanding and communicating the basic science behind both natural climate cycling (e.g. Milankovitch/ENSO) and more recent anthropogenic forcings (e.g. fossil fuel burning and agricultural practices).

- Physical drivers of climate change over different temporal scales
- Paleoclimate research (ice cores, glacial environments, sediment records, isotopes, Heinrich events)
- Examining the science behind climate research (ocean and atmosphere)
- Global modelling of climate and the IPCC assessment process – communicating climate science to the public and policymakers
- How land/ocean use practices can alter ecosystems resulting in changes to climate, including climate mitigation/geoengineering strategies

On successful completion of the course, students will be able to:

- Critically discuss the basic science behind the natural processes that impact global climate. Explain the role of the IPCC and how it works
- Recognize and interpret geological and chemical indicators of present and past global change in the environment (atmosphere, water, sediment/mineral).
- Evaluate and appraise how human activities can be drivers of global change
- Develop knowledge of current climate change adaptation strategies

Prerequisite Course: EOS2102 *The Earth: From Core to Crust* (may be waived at the discretion of EOS)

Target Groups: Core for EOS students, open to students from other disciplines interested in the physical aspects of climate change.

Fourth Year	EOS403 *Field Project/ Honours Dissertation*	Summer & Semester 1 20 ECTS

Assignment of this course is based on third year grades and class ranking.

Aims: This course will provide students with the advanced field and computational skills that are required for Earth and Ocean Sciences graduates seeking employment in either research or industry. The underlying core philosophy is to have students

- Collect a wide variety original data in the field, in a range of environments
- Process & analyse this data (i.e. to solve problems) *and*
- Produce an original (dissertation) report.

In addition, students are required to carefully plan and organise the logistical side of their project (i.e. engage in project management) and to produce deliverables (presentations, drafts and a final report) according to deadline.

Course Convenor: ***Eve Daly*** Lecturers: ***EOS Academic Staff***

Format & duration: Fieldwork (*where safe and appropriate*) and lab work will be completed in the summer months between third and fourth year, and also in Semester 1. Workshops, seminars and presentations will be timetabled through Semester 1, along with any required additional lab analyses. The work will be presented in a dissertation in the early part of Semester 2.

Assessment: The course will be examined by continuous assessment of: performance during completion of the project; data acquisition (evidence from notebooks etc.), data processing, data interpretation, poster and oral presentations, draft final report and the quality of the completed thesis (dissertation). A detailed list of deadlines and timetable for submission will be given to students at the start of fourth year.

Structure:

- Field data collection, processing and interpretation
- Generation of maps, images and profiles
- Presentation of results in both oral and poster formats
- Report (thesis) writing and submission, along with field sheets and notebooks

Recommended Reading:
Contingent on the project topic being investigated – project supervisors will advise students accordingly.

Prerequisite Courses: EOS3101, EOS3104 and an additional 30 ECTS (minimum) from EOS 3rd year

Target Groups: Compulsory for EOS students, unless assigned EOS4102 *Minor Project* (*see below*).

Fourth Year	EOS4102 *Minor Project*	Semester 1 5 ECTS

Assignment of this course is based on third year grades and class ranking.

Aims: This course will provide students with a range of key transferable and communication skills that are highly valuable for Earth and Ocean Sciences graduates seeking employment in either research or industry. Students will complete a desktop study of the geology and geomorphology of a specific area (or region) in Ireland, and then produce a field-guidebook suitable for a general reader. The underlying core philosophy of the minor project programme is to have students:

- Collate a variety pre-existing geological data for a particular area *and*
- Process, appraise & analyse this data to assess its significance *and*
- Produce a fully illustrated report, suitable for the general public.

In addition, all students registered on the minor project programme will need to work together as a team to decide on the precise layout, format and presentation of the guidebooks. It is essential that they are produced to a uniform visual aesthetic. Although largely lab-based, project management will be the responsibility of the student learner, including delivery of presentations, drafts and a final guidebook according to deadline.

Course Convenor: ***Martin White*** Lecturer(s): ***Martin White***

Format & Duration: 12 weeks, 2 to 3 hours workshops per week plus 12 hours independent work per week

Assessment: The course will be examined by continuous assessment of: performance during completion of the project; quality of data collation and processing, poster and oral presentations, draft report and the quality of the completed guidebook. A detailed list of deadlines and timetable for submission will be given to students at the start of fourth year.

Structure:

- Desktop study collation of pre-existing data
- Generation of maps, illustrations and images, suitable for a general audience
- Presentation of results in both oral and poster formats
- Guide-book writing and submission

Recommended Reading:

Contingent on the specific geographic area being investigated – project supervisors will advise students accordingly.

Prerequisite Courses: EOS3101, EOS3104 and an additional 30 ECTS (minimum) from EOS 3rd year

Target Groups: Compulsory for EOS students unless assigned EOS403 *Final Year Project* (*see above*)

Fourth Year	**EOS405 *Field Skills in Oceanography (SMART Shiptime)***	**Semester 1 Weeks 5-12 5 ECTS**

Aims:
This course will provide students with advanced shipboard training in survey planning and oceanographic sampling techniques and data analysis for environmental impact assessment.

Course Convenor: ***Anthony Grehan*** Lecturers: ***Anthony Grehan***, ***Oisin Callery***

Format and Duration: This is a designated SMART (Strategic Marine Alliance for Research and Training) national marine training course (www.smartseaschool.com), composed of lectures, QGIS tutorials, followed by two-day shipboard training in environmental impact assessment techniques. Ship-time training will take place between November 9th and 16th, 2021, in Cork Harbour.

Structure:
- Lectures in pre-survey planning and data analysis tutorials (GIS, ODV etc)
- Shipboard training (SMART)

Assessment:
- Cruise planning and GIS (20%)
- Shipboard Survey report (80%)

On successful completion of the course, students will:
- Be aware of the necessary steps involved in planning a research survey
- Be able to use QGIS in cruise planning and the calculation of the time needed at sea to accomplish survey goals and post-cruise to produce a map of survey locations
- Be familiar with the workings of a research vessel including health and safety requirements
- Collect, record and appraise scientific data with a variety of sampling gears at sea
- Produce a professional cruise report
- Be familiar with the requirements of Environmental Impact Assessment in a marine setting

Recommended Reading:
Self-guided learning based on material provided on Canvas

Prerequisite Courses:
- EOS213 *Introduction to Oceanography* and
- Either EOS303 *Ocean Dynamics* or EOS304 *Aquatic Geochemistry*

Target Groups: Final year EOS and Marine Science students

Fourth Year	**EOS418 *Applied Field Hydrogeology***	**Semester 1 Weeks 7-12 5 ECTS**

Aims: Groundwater is one of our key water resources, yet it is also one that is stressed by natural processes and human activities. Managing groundwater is a mix of science, regulation and politics. This course focuses on understanding groundwater in its geological setting and explores the ways in which groundwater affects and is affected by the medium in which it is stored and through which it flows.

Course Convenor:r: ***Tiernan Henry*** Lecturer: ***Tiernan Henry***

Assessment: Two-hour theory examination (70%) and continuous assessment (30%)

Format & Duration: 24 lectures, four homework assignments . There will be four lecture hours per week.

Structure:
- Analysis and explanation of pumping tests and pumping test outputs; Interpretation of data outputs in the context of geology and hydrogeology;
- Assessment and examination of groundwater chemistry data sets to generate hydrochemical facies;
- Contrast and distinguish between conflicting genetic models of mineral deposition;
- Critically examination of hydraulic fracturing as a means of resource extraction.

On successful completion of the course, students will be able to:
- Analyse and explain pumping test data outputs
- Interpret data outputs in the context of geology and hydrogeology
- Assess and examine groundwater chemistry data sets to generate hydrochemical facies
- Contrast and distinguish between conflicting genetic models of mineral deposition
- Critically examine hydraulic fracturing as a means of resource extraction
- Undertake critical evaluation and review of reports and research papers
- Frame research questions in the context of water resource management.

Recommended Reading:
- Brassington, R. (2017) *Field Hydrogeology 4th Ed*. Wiley, London
- Fetter, C.W. (2001) *Applied Hydrogeology 4th Ed*. Prentice Hall, New York
- Freeze, R.A. & Cherry, J.A. (1979) *Groundwater*. Prentice Hall, New York
- Domenico, P.A. & Schwartz, F.W. (1998) *Physical and Chemical Hydrogeology 2nd Ed*. Wiley, London

Prerequisite Course: EOS305 *Introduction to Applied Field Hydrology*.

Target Groups: Recommended for students wishing to pursue postgraduate study in hydrogeology or to work in the practice.

Fourth Year	EOS4103 ***Advanced Field Skills***	**Semester 1** **Week 2** **5 ECTS**

Aims:
This 5 ECTS course provides students with experience in a broad and diverse range of field techniques used in Earth and Ocean Sciences. Students will receive training in identifying and describing rocks in the field and using them to interpret geological processes and palaeoenvironments. Additionally, they will receive training in surveying, geological mapping and become familiar with reading the landscape. The ability to collect, process and interpret field data is a key requirement for Earth and Ocean Sciences graduates seeking employment. There will be a cost per student associated with this course, which will cover travel and accommodation

Course Convenor: *Jake Ciborowski* Lecturer: ***EOS staff***

Format and duration: This will be run as a residential fieldtrip, during September.

Assessment: This course will be examined by continuous assessment based on a series of exercises and reports, and field notebooks produced and submitted during the field work.

Recommended Reading: Reading lists will be supplied by the lecturers and available on Canvas prior to the start of the course

Prerequisite Courses:

EOS3101 *Geological Structures & Maps*, EOS3104 *Fieldskills Training* **and** an additional 30 ECTS (*minimum*) from EOS 3rd year.

Target Groups: Final Year EOS only

Semester Two 2024-2025

***All* EOS lecture materials and supporting materials will be available at each *course Canvas* page.**

Second Year	EOS2101 *Introduction to Field Skills*	Semester 2 Weeks 5-12 + 5 ECTS

Aims:
This is a field-based course, which will predominantly be taught during day trips (from Galway) in Week 13. Its aim is to introduce students to basic concepts in the earth sciences, e.g. field relationships, stratigraphy, records of environmental change, and landscape evolution. It also aims to teach the basics skills required to collect and interpret data in the field, e.g. navigation and geological mapping. *It is available to denominated Earth and Ocean Sciences and Environmental Science students only.*

Course Convenor: Sadhbh Baxter **Lecturer:** Sadhbh Baxter

Format & Duration: 8 hours of lectures during Semester 2 and 4-5 days of field trips at the end of Semester 2

Assessment: Continuous assessment (100%)

Structure:
The course will cover: basic field skills; map navigation; the use of the compass clinometer; the principles of stratigraphy; interpretation of sedimentary depositional environments; Irish geological history; field studies of igneous and metamorphic rocks; field relationships; geological map production.

On successful completion of the course, students will be able to:
- Recognise and interpret different field relationships and contacts
- Record the spatial distribution of rocks and produce a geological map
- Identify and explain the origin of sedimentary structures
- Measure the orientation of dipping layers
- Navigate ordnance survey maps
- Interpret ancient depositional environments from the sedimentary record
- Relate observations made in the field to Irish geological history
- Recognise a range of igneous and metamorphic rocks in the field

Recommended Reading:
- Holland, C.H. & Sanders, I. (Eds.) (2009) *The Geology of Ireland 2nd Ed*. Dunedin Press
- **Online Resources:** www.gsi.ie (particularly the 'Data & maps' and 'Education' options – the 'Understanding Earth Processes' book is available to download as a pdf and includes a simplified geological history of Ireland.)

Prerequisite Courses: None

Target Groups: Compulsory for all Denominated EOS and EV students

Second Year	EOS2102 *The Earth: from Core to Crust*	Semester 2 Weeks 1-12 5 ECTS

Aims: This course will investigate the entire earth system, from core to crust, through geological time and from a range of scales. Students will learn about the origins of the Earth and the broad-scale tectonic forces that underpin the formation and destruction of continents. It will investigate the composition of the crust from both mineralogical and resource-potential perspectives and examine the processes that modify and sculpt the surface of our planet. Students will study the evolution of life and the interaction between the biosphere and earth, including the impact of geology on human civilisation. This will be carried with a specific focus on current geohazards and the future challenges facing our planet.

Course Convenor: ***Shane Tyrrell*** Lecturers: ***EOS Academic Staff***

Format and Duration: 36 lectures plus 24 hours supervised practical laboratory work and independent learning.

Assessment:
Paper 1: Multiple choice exam (25%); ***Paper 2***: Essay paper (25%); ***Continuous Assessment*** (50%) Combination of online multiple choice quizzes (10%) practical assignments and homework exercises (40%).

Structure: *Thematic areas covered include:* Origins, Earth structure and age; Earth materials; Life on Earth**;** Earth surface processes**;** Earth resources**;** Imaging the Earth**;** Geohazards and challenges.

On successful completion of the course, students will be able to:
- Discuss the origins of the Earth and the solar system
- Identify a variety of earth materials, minerals and resources and appreciate their origin, occurrence and geological significance
- Visualise the Earth and its geology in 3D and describe the techniques used to image the subsurface of the planet
- Explore large-scale earth structure and plate tectonics
- Describe the operation of earth surface processes and how the sedimentary record provides an archive of palaeoenvironmental change through geological time
- Describe a range of current risks and geohazards and examine the impact of these on our planet
- Identify a range of fossil materials and have an appreciation for the evolution of the biosphere and its impact on earth.

Recommended Reading:
- Marshak, S. (2010) *Earth: Portrait of a Planet 4th Ed*. W.W. Norton, New York

Prerequisite Courses: None
Target Groups:
- *Compulsory* for EOS and EV students
- *Optional* for Undenominated Science and Marine Science students

Third Year	EOS303 *Ocean Dynamics*	Semester 2 Weeks 1-6 5 ECTS

Aims:
This course will introduce students to the forces that control ocean and shelf dynamics. The course will introduce the different types of ocean currents and features such as wind driven flow, turbulence and mixing/diffusion. The fundamental links between these dynamics and basic biogeochemical cycling (nutrient and phytoplankton dynamics) will be explored.

Course Convenor: ***Martin White*** Lecturer: ***Martin White***

Format & Duration: 18 lectures and 6 x 3hour practical exercises. The Continuous Assessment comprises two stand-alone exercises and four that involve practical work and data analysis, on a city canal to assess the dynamics and flow characteristics, summarised in a short (2pg report).

Assessment: Two-hour theory examination (60%) and continuous assessment (40%).

Structure:
- Basic forces that drive ocean circulation
- Large scale geostrophic, wind driven circulation, shelf sea dynamics
- Turbulence, mixing and vorticity
- Large scale nutrient and phytoplankton dynamics
- Benthic currents and sediment dynamics

On successful completion of the course, students will have:
- An appreciation of scales, dimensional analysis and problem solving
- Understand the different balance of forces and flow character in shelf sea and deep ocean and aspects of some associated biophysical interactions
- Completed a case study through measurement and analysis of collected data
- Developed skills appropriate for a career in marine geoscience

Recommended Reading:
- Stewart, R.H. (2008) *Introduction to Physical Oceanography*

This is an online book that will be provided on Canvas in pdf format

Pre-requisite Course: EOS213 *Introduction to Oceanography*

Target Groups:
- All Denominated EOS and Undenominated Science students
- Compulsory for Marine Science students
- Recommended for Physics, Chemistry, Zoology, Botany and Microbiology students

Third Year	EOS304 *Aquatic Geochemistry*	Semester 2 Weeks 7-12 5 ECTS

Aims: Students will be introduced to the quantitative treatment of chemical processes in aquatic systems, including a brief review of chemical thermodynamics and photochemistry as it applies to natural waters. Specific topics include acid-base chemistry, precipitation-dissolution, coordination, and redox reactions. Emphasis is on equilibrium calculations as a tool for understanding the variables that govern the chemical composition of aquatic systems and the fate of pollutants.

Course Convenor: ***Peter Croot*** Lecturer: ***Peter Croot***

Format & Duration: 18 lectures, 3 hours per week (*in person where practical, lecture materials available online*), & one tutorial per week (1 hour). The continuous assessment is based on a weekly exercise (on Canvas) that examines the student's knowledge and understanding of the course materials.

Assessment: Two-hour theory examination (70%) and continuous assessment (30%)

Structure:
- Introduction to the key geochemical and biogeochemical processes in natural waters
- Acid/Base chemistry; Precipitation of solids from solution
- Redox reactions (Pourbaix diagrams); Complexation kinetics
- Photochemistry in Aquatic Systems

On successful completion of the course, students will be able to:
- Construct and balance chemical equations for reactions in aquatic systems
- Calculate the solubility of minerals & construct stability diagrams
- Use geochemical analyses of rocks and waters to determine and quantify weathering reactions, describe the main factors that control weathering rates
- Know the main chemical elements and compounds of river water and sea water and explain why they are present and what sets their concentration
- Explain important principles for oceanic element budgets and mass balances
- Describe the behaviour of light in aquatic systems

Recommended Reading:
- Chester, R.C. & Jickells, T.D. (2012) *Marine Geochemistry 3rd Ed.* Wiley Blackwell
- Howard, A.G. (1998) *Aquatic Environmental Chemistry*. Oxford Chemistry Primers. OUP

Prerequisite Course: EOS213 *Introduction to Oceanography*

Target Groups: All EOS students and students from other disciplines interested in the fundamental of (bio)geochemistry in natural waters.

Third Year	EOS3101 *Geological Structures & Maps*	Semester 2 Weeks 1-12 5 ECTS

Aims: Structural geology, the study of deformation in our planet's crust, is a core subject in the earth sciences. This course aims to cover the fundamentals of structural geology from both a descriptive and mechanistic perspective and will examine these processes at micro (e.g. individual crystals) to macro-scales (global tectonics). Topics will include stress, strain, folding, faulting and plate tectonics. The course will be underpinned by practical work where the students will be introduced to methods and approaches used in interpreting geological maps, relationships and structures in 3-D.

Course Convenor: ***Jake Ciborowski*** Lecturer: ***Jake Ciborowski***

Format & Duration: 12 four-hour combined lectures and practicals.

Assessment: 2-hour written exam (50%); Continuous assessment of practical classes and a practical exam (50%).

Structure:
Topics will include stress and strain, fracturing and faulting, microscale deformation, folding, foliation and lineation development, shear zones, and plate tectonics. The course will be underpinned by practical work including the structural data, and training in the methods and approaches used interpreting geological maps and constructing geological cross-sections.

On successful completion of the course, students will be able to:
- Discriminate and classify geological structures and describe how they are formed
- Investigate large-scale earth structures and plate tectonics
- Investigate and contrast stress and strain in rocks
- Use 2-D map data to create 3-D interpretations of subsurface geology
- Interpret geological relationship, structures, and histories based on mapped data

Recommended Reading:
- Fossen, H. (2010) *Structural Geology,* Cambridge University Press

Prerequisite Courses: EOS2102 *The Earth: From Core to Crust*

Target Groups: Core for third year Denominated EOS students, optional for Undenominated Science students

Third Year	**EOS3102** ***Environmental Geophysics & Remote Sensing***	Semester 2 Weeks 7-12 5 ECTS

Aims: This course will introduce students to a series of geophysical remote sensing techniques for exploring the near-surface in both terrestrial and marine environments. The results will be used to explain key chemical, geological, hydrogeological and physical processes beneath the surface and how these can aid the monitoring of geo-hazards and management of near-surface resources. Specifically the course will introduce students to an array of Geophysical methods.

Course Convenor: ***Eve Daly*** Lecturer: ***Eve Daly***

Format & Duration: 18 lectures and 6 three-hour practicals (*some online*).

Assessment: Two-hour theory exam (70%) and assessment of practical work (30%)

Structure:
- Terrestrial and marine Gravity and Magnetic methods and case studies
- Terrestrial and marine seismic methods and case studies
- Terrestrial and marine electrical methods and case studies
- Topographic and bathymetric mapping

On successful completion of the course, students will be able to:
- Describe the theory and field operation of a range of applied geophysical methods
- Distinguish between each method and when they should be used
- Interpret data from the above datasets in a geological context.
- Design a geophysical survey to investigate a certain problem, given site history and regional geology.

Recommended Reading:
- Reynolds, J. (2011) *An Introduction to Applied and Environmental Geophysics 2nd Ed.*, Wiley
- Mussett, A.E. & Khan, M.A. (2000) *Looking into the Earth: An introduction to geological Geophysics*, Cambridge University Press
- Gibson, P.J. & George, D.M. (2003) *Environmental Applications of Geophysical Surveying Techniques,* Nova Biomedical
- Jones, E.J.W. (1999) *Marine Geophysics*, Wiley

Prerequisite Courses: EOS2102 *The Earth: From Core to Crust* & PH101 First Year physics

Target Groups:
Core for Denominated EOS students (3EH1), optional for Marine Science (3MR1), Undenominated Science (3BS1) and Environmental Science (3EV1) students.

Third Year	EOS3104 *Fieldskills Training*	Semester 2 Week 12+13 5 ECTS

Aims: This course is largely field-based and will provide students with the basic field skills that are required for EOS (both in research and industry). They will gain experience in dealing with a wide range of rock types and structures in the field and will learn how to subsequently digitise maps and logged sections (created in the field) for presentation purposes. This course is specifically designed prepare EOS students for their dissertation work in the final year.

Course Convenor: ***John Murray*** Lecturers: ***John Murray, Tiernan Henry***

Format & Duration: This course is almost entirely field-based. Students complete several days of intensive (residential) fieldwork at the start of April 2024 (immediately after the end of Week 12 of S2). There will be some preparatory briefing workshops prior to the fieldtrip and additional computer processing/work upon returning to the university.

Assessment: Continuous assessment of field sheets, maps & notebooks (100%).

On successful completion of the course, students will be able to:

- Collect & record qualitative and quantitative field data and subsequently appraise it
- Identify and describe a wide range of rock and sediment types at outcrop level
- Interpret palaeoenvironments of different geological units using sedimentology and palaeontology (body and trace fossils)
- Apply standard methods for hydrogeological investigations
- Appraise the degree to which the underlying geology of any given area influences landscape development and evolution
- Construct a geological/geomorphological map for a given study area
- Compile a digitised (computer) version of the map produced for presentation purposes

Recommended Reading:

- Barnes, J.W. & Lisle, R.J. (2003) *Basic Geological Mapping* 4th Ed., Wiley-Blackwell
- Stow, D.A.V. (2005) *Sedimentary rocks in the field*, Manson
- Goldring, R. (1999) *Field Palaeontology* 2nd Ed., Longman
- Brassington, R. (2017) *Field Hydrogeology*, 4th Ed.

Prerequisite Course: A minimum 20 ECTS EOS second year courses
Co-requisites: EOS3101 *Geological Structures & Maps* and an additional 30 credits of EOS courses in third year.

Target Groups: Core for Denominated EOS students and compulsory for Undenominated Science students who are considering continuing in EOS in 4th year. Undenominated students should carefully note the prerequisites and co-requisites required (*see above*).

Fourth Year	EOS407 *History of Life*	Semester 2 Weeks 1-6 5 ECTS

Aims: This course will explore, in detail, the major events in the story of the evolution of life on Earth, as relayed to us through the fossil record. Topics to be covered will include the origin of life, appearance of eukaryotes and development of metazoans (multicellular organisms) in the Precambrian; the Cambrian Explosion and Ordovician Biodiversification Events; the conquest of terrestrial environments); mass extinctions and the rise of mammals in the Paleogene and Neogene. The ethos of this course will be quite holistic in approach (i.e. using a wide range of geological, palaeontological as well as biological data sources); however, the narrative will be from a palaeontological perspective.

Course Convenor: ***John Murray*** Lecturer: ***John Murray***

Format & Duration: 20 lectures (online) and 10 two-hour workshops.

Assessment: Two-hour theory exam (70%) and assessment of practical work (30%).

Structure: The origin of life in a harsh primeval Precambrian world (setting the scene); origin of eukaryotes and the Garden of Ediacara; Cambrian Explosion and the Burgess Shale; Ordovician biodiversification; conquest of land; Mesozoic monsters and their feathered friends; mass extinctions; the rise of mammals in the Cenozoic

On successful completion of the course, students will be able to:

- Discuss and appraise the various theories relating to the origin of life on earth.
- Recount (in chronological order) and describe the significant events in the history of life.
- Discuss and appraise the effects the earth has had on influencing the evolution of the biosphere (and vice versa).
- Critically assess the currently accepted hypotheses and models, which attempt to explain the significant events in the evolutionary history of life.
- Compile scientific information, from a number of sources, and use this to prepare a script and storyboard for a documentary film.
- Employ the script and storyboard developed in LO5 to produce a short documentary-style film, which will communicate or explain an evolutionary idea or concept to a wider audience.

Recommended Reading:

- Benton, M.J. (2019) *Cowen's History of Life (6th Edition)*, Blackwell Publishing
- Briggs. D.E.G. & Crowther P.R. (Eds.) (2001) *Palaeobiology II*. Blackwell Science
- Selden, P. & Nudds, J. (2005) *Evolution of Fossil Ecosystems*. Manson Publishing

Prerequisite Course: EOS3103 *Palaeontology & Evolution*

Target Groups: Optional for Denominated EOS students. Also recommended for denominated Marine Science students and final year biologists (in particular zoologists and botanists) - provided they have fulfilled the prerequisites.

Fourth Year	EOS409 *Biophysical Interactions in the Oceans*	Semester 2 Weeks 7-12 5 ECTS

Aims: This course examines biophysical and biogeochemical interactions in the ocean through critical reviews of a series of peer reviewed published literature on a number of topics related to ecosystem functioning at the continental margin and other topographic features. Linkage of physical processes to biogeochemical cycling and biological distribution and habitat function will be demonstrated.

Course Convenor: ***Martin White*** Lecturer: ***Martin White***

Format & Duration: 24 lectures (4 hours per week). Continuous assessment involves students abstracting scientific papers and producing a presentation and report on a topic covered in the course syllabus, plus analysing and reporting on Copernicus Marine data.

Assessment: Two-hour theory examination (50%) and continuous assessment (50%)

Structure:
The course focuses on seamounts and benthic ecosystems, seasonal fluxes to the deep sea, frontal processes, global influences and feedbacks. Tutorials are used to highlight the basic physical and chemical processes related to a number of case studies and elements are critically analysed through review of 3-4 publications on each topic.

On successful completion of the course, students will have acquired:
- Critical review/analysis skills of published reports/works
- Abstract writing and other writing/presentation skills
- Skills appropriate for a career in marine geoscience

Recommended Reading:
To be supplied by lecturers. Typically 3 topics with ~4 publications per topic

Prerequisite Courses: EOS303 *Ocean Dynamics* or EOS304 *Aquatic Geochemistry*

Target Groups:
Optional for denominated EOS (4EH1) students. Also recommended for denominated Marine Science students and final year biologists (in particular zoologists and botanists) - provided they have fulfilled the prerequisites.

Fourth Year	EOS422 *Sedimentary Basins*	Semester 2 Weeks 7-12 5 ECTS

Aims: Sedimentary basins comprise a long time-scale record of environmental change on the earth's surface and are hugely economically important. Almost all commercial hydrocarbons are contained within sedimentary basins – they also comprise groundwater aquifers, potential sites for sequestered carbon dioxide, mineral resources and are important sources of geothermal heat. This course will investigate the origin, evolution and architecture of sedimentary basins, and examine in detail the many techniques which are used in basin analysis.

Course Convenor: ***Shane Tyrrell*** Lecturer: ***Shane Tyrrell***

Format & Duration: 10 workshop sessions and 5 assignments

Assessment: Two-hour written paper (70%) and continuous assessment (30%)

Structure:
- Origin, formation and structure of basins
- External and internal controls on basin fill and architecture
- Use of geophysical techniques in basin analysis
- Correlation and dating of sedimentary sequences
- Thermal and burial history of basins
- Sequence stratigraphy
- Energy transition

On successful completion of the course, students will be able to:
- Describe the origin and evolution of sedimentary basins
- Outline the fundamental elements of basin analysis
- Investigate the factors that control sediment dispersal into basins
- Assess the role that sedimentary bas ins play in terms of energy and natural resources
- Describe the elements of petroleum plays and the petroleum system concept
- Communicate the results of individual research to an audience of peer
- Describe the geophysical techniques used to characterise sedimentary basins in the subsurface

Recommended Reading:
- Allen, P. & Allen, J.R. (1990) B*asin Analysis – principles and applications*.
- Nichols, G. (2009) *Sedimentology and stratigraphy*.
- Leeder, M.R. (2010) *Sedimentology and sedimentary basins*.

Prerequisite Course: EOS323 *Sediments & the Sedimentary Record*

Target Groups: Strongly recommended for EOS students

Fourth Year	EOS4101 *Earth Observation & Remote Sensing*	Semester 2 Weeks 7-12 5 ECTS

Aims: This course will introduce students to an array of Remote sensing techniques used in Earth Observations. It will include Satellite, Airborne (plane and drone) and Marine based technologies. Students will be introduced to the theory of electromagnetic radiation, remote sensing systems, Multispectral scanners, Radar instruments, Photogrammetry. Image processing and image interpretation will also be covered. The data provided from these methods can be used to help understand the physical, chemical, and biological processes acting on the earth's surface. Applications include environmental monitoring climate change. Specifically geological mapping, marine and terrestrial habitat mapping, agriculture, coastal erosion, flood mapping, land use mapping and archaeology will be covered.

Course Convenor: ***Eve Daly*** Lecturer**:** ***Eve Daly***
Format & Duration: 30 lectures, three 3-hour homework exercises.

Assessment: Two-hour theory examination (70%) and continuous assessment (30%)

Structure:
- Theory behind passive Electromagnetic remote sensing and Active remote sensing methods of Radar, Lidar and Acoustics
- Acquisition and image processing procedures
- Case studies

On successful completion of the course, students will be able to:
- Explain the concept of electromagnetic energy (EM) including the principles of remote sensing (sources of radiation, EM energy interaction with the atmosphere, EM energy interaction with terrestrial targets, spectral properties of terrestrial targets).
- Appreciate the variety of sensors available and their resolution properties (i.e. spatial, spectral, radiometric, and temporal)
- Grasp the principle of image acquisition from a variety of platforms. Satellite, Airborne and Drones and integration of remotely sensed images into a GIS environment
- Relate remote sensing technologies to successful applications of Earth observation and monitoring (e.g., geology, atmospheric sciences, water resources, oceanography, agriculture, and forestry)

Recommended Reading:
- Campbell, J.B. (2011) *Introduction to Remote Sensing 5th Ed.* Guilford Press.
- Martin, S. (2014) *An Introduction to Ocean Remote Sensing 2nd Ed*. Cambridge University Press.

Prerequisite Courses: EOS2102 *The Earth: From Core to Crust* and/or PH101 (First Year Physics)

Target Groups: All EOS and non-denominated students

Fourth Year	**EOS4105 *Economic Geology: Principles, Practice & Sustainability***	**Semester 2 Weeks 1-12 5 ECTS**

Aims:.
This course aims to provide students with a comprehensive introduction to the fundamental concepts of and new frontiers in Economic Geology. Students will study the variety of mineral deposits and ore-forming processes. The genetic models of major types of ore deposits will be illustrated through world-class examples. Ore characterisation skills will be gained through practical studies. Emerging opportunities and challenges in Economic Geology will be also outlined and discussed, stressing the urgent role that mineral resources play in achieving a sustainable future.

Course Convenor: ***Jake Ciborowski*** Lecturer: ***Jake Ciborowski***

Format & Duration: 11 four-hour combined lectures and practicals and one four-hour offsite field excursion.

Assessment: Two-hour theory examination (60%) and continuous assessment (40%)

Structure:
The course will cover four thematic areas related to Economic Geology: Introduction to Economic Geology; Ore-forming processes; Exploration and Mining; New frontiers and sustainability in Economic Geology. These thematic areas are linked to the more general EOS courses available at 2nd and 3rd year levels

On successful completion of the course, students will be able to:
- Describe and evaluate the variety of mineral deposits
- Demonstrate knowledge of the variety of ore-forming processes from an Irish and global perspective
- Characterise common rock types and minerals found in and around ore deposits
- Evaluate the central role of mineral resources in sustainable development
- Apply knowledge of Economic Geology to develop practical sustainability solutions

Recommended Reading:
- Okrusch, M. & Frimmel, H.E. (2020) *Mineralogy: An introduction to Minerals, Rocks and Mineral Deposits*, Springer
- Ridley, J. (2013) *Ore Deposit Geology*, Cambridge University Press
- Robb, L. (2020) *Introduction to Ore-Forming Processes*, 2nd edition Ed., Wiley-Blackwell

Prerequisite Courses: EOS3105, EOS3106, EOS3101, EOS323

Target Groups: All EOS students

Teaching and Learning

The most critical concept for students to grasp is that you are here to learn. The teaching we deliver is only one part of that process – the rest of the work you must do yourself. You are expected to read widely around the subject matter you are given in lectures and practicals, and to apply what you learn in the field. **Turning up for lectures and practicals is less than half of the work you need to put in each week for each course.**

The EOS degree is arranged in courses. Each year you take 60 credits made up of 5, 10 or 20 credit courses and you are examined on each course at the end of the semester it falls in (and during the course in a variety of continuous assessments). Despite this element of self-containment, the EOS degree should be seen as a whole and the component parts (courses) follow on from one another in a coherent pattern. Each year builds on the previous year, and with each year there is a shift in the teaching and learning approach: as you progress from first year to final year, there is an expectation that you will take more ownership of your learning, and develop new learning skills. *At the end of your undergraduate studies you will be awarded a degree that depends upon marks that you accumulate in your third and fourth years.* ***Your third year marks will count towards 30 percent of your final degree mark and the remaining 70 percent will depend upon your marks in fourth year****. It is critical therefore that you improve your marks year on year to achieve your desired degree level.*

Teaching and learning in EOS is structured around lectures, practical classes, field work and seminars. The lectures are typically 50 minutes long. Each individual course will usually have some practical or continuous assessment component. In second year, in addition to lectures, EOS courses will begin to introduce project-based teaching in which students will be expected to submit written essays or scientific reports. We value good writing and it is a significant part of the learning process in the EOS degree. Writing essays or reports is perhaps the most powerful of all methods for coming to grips with a subject and you should take them very seriously. They are the most rigorous test for finding out whether you really understand something, and report writing is a fundamental skill requirement in the jobs market.

In third and fourth years, students will begin to do both group and individual presentations in courses. These presentational skills are useful at university and in the workplace. Some of these courses are examined in whole or in part by essays or project reports, formally submitted after the end of the course.

Teaching and learning are of course closely interconnected. The way our courses are structured and the way we teach are designed to encourage you to become a self-directed, independent learner. That means we expect you to organise much of your own learning time, in terms of attending lectures and practicals, taking the appropriate notes, reading background material, and, in later years, preparing for seminars, producing presentations, writing essays and so on. Feedback from students is critical in continually improving the courses. A *Student Evaluation Questionnaire* is given out towards the end of each course and filled in by you anonymously. Members of staff look at their own forms to see where improvements can be made. This does not preclude you from talking to staff members about the nature of the courses, where you think there could be improvements or even, if you feel like it, mentioning the good points about courses. You can also feedback comment through your student representative.

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