EG3031 Special Topic for Physical Geography

SCOTCAT Credits:	5	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Available only to Geography students			
Planned timetable:	To be arranged.			
This module provides support and guidance for geography students taking ES3020 or ES4020 as a 5 credit top-up. In addition Geography MA and BSc students taking 15-credit modules from the Science Faculty may find themselves 5 credits short and this module provides the necessary credit top-up.				
Pre-requisite(s):	Before taking this module you must pass GG2011 and pass GG2012			
Co-requisite(s):	You must also take ES3020 or take ES3011			
Learning and teaching methods of delivery:	**Weekly contact**: Occasional tutorials.			
	Scheduled learning: 8 hours		**Guided independent study:** 42 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available			
Module coordinator:	Professor R J S Wilson			
Module teaching staff:	Dr R Wilson, Dr J Rae, Dr A Burke, Dr M Byrne			

ES3001 Geoscience Field Techniques

SCOTCAT Credits:	15	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	To be arranged.			
This module provides training in independent geological mapping, cross-section construction and geophysical and remote sensing techniques. It is designed to refine skills in envisaging, reconstructing and understanding geological structures in 3-D and in analysing 4-D problems that are commonplace to many geoscientific activities.				
Pre-requisite(s):	Before taking this module you must pass ES2001 and pass ES2002			
Learning and teaching methods of delivery:	**Weekly contact**: 4 maps and geophysical practicals (3 hours each) and lectures over 10 weeks and occasional 2-hour fieldwork tutorials.			
	Scheduled learning: 19 hours		**Guided independent study:** 131 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor A R Prave			
Module teaching staff:	Prof T Prave, Dr C Bates			

ES3002 Data Analysis in Earth Sciences

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	11.00 am - 1.00 pm Mon (analytical methods), 2.00 pm - 4.00 pm Thu (stats)			
This module covers the principles behind, and practical application of data handling, visualisation and analysis in Earth Sciences. Statistical training includes (i) understanding data types, (ii) data presentation and basic descriptive statistics, (iii) probability, (iv) hypothesis testing using parametric and non-parametric statistics, (v) correlation and regression, and (vi) introduction to numerical methods and modelling. Skills taught here reinforce Earth Sciences honours teaching, particularly the independent research dissertation module.				
Pre-requisite(s):	Before taking this module you must pass ES2001 and pass ES2002 or pass ES2003			
Learning and teaching methods of delivery:	**Weekly contact**: 3hr x 10 weeks			
	Scheduled learning: 55 hours		**Guided independent study:** 95 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	Oral Examination = 100%			
Module coordinator:	Professor R J S Wilson			
Module teaching staff:	Dr R Wilson, Dr M Byrne			

ES3003 GIS and Spatial Analysis for Earth Scientists

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	10.00 am - 1.00 pm Mon, Wed (lecture plus lab session) (Weeks 1 - 7)			
This module covers the principles behind, and practical application of digital spatial analysis in Earth Sciences. This includes the analysis of primary and secondary datasets, how to access and import a variety of data types, and the fundamentals of various spatial analytical methods including spatial statistics and modeling within a GIS environment. The module also prepares students for the correct presentation of maps and datasets in the dissertation proposal and thesis.				
Pre-requisite(s):	Before taking this module you must take ES3002			
Learning and teaching methods of delivery:	**Weekly contact**: Two 3 hour practical demonstrated classes per week run in IT classrooms using ArcGIS software. This will allow for remote log on by students who cannot attend the class in person. If distancing measures are in place then more than one IT classroom will be needed.			
	Scheduled learning: 48 hours		**Guided independent study:** 102 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr C R Bates			
Module teaching staff:	Dr C Bates			

ES3004 Processes and Products in Sedimentary Systems

SCOTCAT Credits:	15	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	9.00 am - 10.00 am Tue - Thu (lectures), 2.00 - 5.00 pm Mon (practicals). 3 field days (9.00 am - 5.00 pm)			
This core module provides fundamental knowledge and training in describing, studying and interpreting sediments, sedimentary rocks and stratigraphic frameworks. The concepts and methodologies of process sedimentology, stratigraphy and sedimentary petrography will be taught, and training undertaken using fieldwork and practicals. The module serves as preparation for subsequent modules on related topics and for field-based modules, including Advanced Geological Mapping, the Research dissertation, and the fourth-year field course.				
Pre-requisite(s):	Before taking this module you must pass ES2001 and (pass ES2002 or pass ES2003)			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures (x11 wks), 4 practicals (x4 wks), 2 fieldtrips (2 days)			
	Scheduled learning: 55 hours		**Guided independent study:** 98 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	Practical Examination = 100%			
Module coordinator:	Professor A R Prave			
Module teaching staff:	Prof T Prave, Dr C Rose			

ES3006 Advanced Field Skills in Earth and Environmental Sciences

SCOTCAT Credits:	15	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Be enrolled in an honours BSc or MGeol in the University			
Planned timetable:	To be confirmed			
This module provides advanced field skills required by Earth and Environmental Science students to record and interpret field data. The module is divided into five units: 1) lectures and practicals on field techniques with training sessions based in St Andrews, 2) a residential field course (currently NW Highlands) focussing on mapping and interpreting of rocks, 3) a residential field course (currently Mull) focussing on mapping and geological histories, 4) a lab-based desk study of environmental impact and monitoring in a particular field area (currently Rio Tinto mine in Spain) and 5) A field visit to that area. BSc Geology and Geology/Chemistry students do units 1,2,3; BSc Environmental Earth Sciences and Geology/Biology students do 1,4,5; MGeol Earth Sciences students do 1,2 and have the option of either 3 or 5. At the end of the module, students will have learned how to record, interpret and present field data and to visualise Earth and Environment in four dimensions.				
Pre-requisite(s):	Before taking this module you must pass ES3001			
Learning and teaching methods of delivery:	**Weekly contact**:			
	Scheduled learning: 24 hours		**Guided independent study:** 126 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: 100% Coursework			
Re-assessment pattern:	100% Coursework			
Module coordinator:	Professor A A Finch			
Module teaching staff:	Dr Mark Claire, Prof Adrian Finch, Dr William McCarthy			

ES3007 Structural Geology and Tectonics

SCOTCAT Credits:	15	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	11.00 am - 12.00 noon Tues (lectures), 2.00 - 5.00 pm (practicals), 10.00 am - 12.00 noon Th (lectures)			
This module covers the principles of rock deformation and the tectonic processes that drive this deformation. The goals of this module are to promote: a) the development of core skills in the structural analysis of rock bodies to gain an understanding of the geometries, sequencing, and kinematics of deformational features; b) understanding of tectonic principles and controls on rock deformation and mountain building.; c) to learn how to apply structural geology skills in the work place. You will learn how to quantitatively evaluate strain distribution, stress fields and the failure envelope, how to evaluate structures arising from polyphase deformation and how to use this use these skills for geotechnical engineering applications. The course includes two compulsory field trips.				
Pre-requisite(s):	Before taking this module you must pass ES2001 and pass ES2002			
Learning and teaching methods of delivery:	**Weekly contact**: 2-3 hr x 7 weeks lectures, 3 hr labs x 7 weeks, 8 hrs fieldwork x 1 week			
	Scheduled learning: 55 hours		**Guided independent study:** 95 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%			
	As used by St Andrews: Written Examination (run as internal test in Week 9) = 50%, Coursework = 50%			
Re-assessment pattern:	2-hour Written Examination = 80%, Coursework = 20%, No Re-assessment if Coursework mark is less than 4			
Module coordinator:	Dr W McCarthy			
Module teaching staff:	Dr W McCarthy, Prof A Prave			

ES3008 Geochemistry

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	10.00 am Tue and Thu (lectures), 2.00 - 5.00 Fri (practicals)			
This module provides an introduction to geochemistry: the study of the abundance, distribution and circulation of the chemical elements in minerals, rocks, soils, water and the atmosphere. Geochemical tools are a powerful means to study geological, economic, and environmental problems. In the module we study the origin and distribution of the chemical elements in the Earth and solar system and review thermodynamics and kinetics as applied to the Earth system. We apply thermodynamics to make quantitative predictions regarding the outcome of chemical reactions associated with geological processes. We consider the behaviour of elements, in both low temperature environments and planetary interiors. Material covered includes introductory chemistry, chemical bonding, thermodynamics, kinetics, aqueous geochemistry, mineral precipitation and dissolution, CO2 change, and planetary chemistry. We utilise geochemical tools to constrain changes in geological processes and Earth's environment.				
Pre-requisite(s):	Before taking this module you must have entered honours and passed ES2001, ES2002 and ES2003			
Learning and teaching methods of delivery:	**Weekly contact**: 2 x 1 hour lectures (8 weeks), 1 x 3 hour practical (8 weeks), 1 field class			
	Scheduled learning: 45 hours		**Guided independent study:** 105 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 100%, Coursework = 0%			
	As used by St Andrews: Practical Examination = 100%			
Re-assessment pattern:	Practical Examination = 100%			
Module coordinator:	Dr J W B Rae			
Module teaching staff:	Dr J Rae, Dr P Savage			

ES3009 Igneous and Metamorphic Petrology

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	9.00 am Tue and Thu (lectures); 2.00 pm - 5.00 pm Mon (practicals)			
This is a core module within the BSc Geology and MGeol Earth Sciences degrees and delivered early in the Honours programme in order to provide a fundamental framework for interpreting major petrological processes acting within the silicate portion of planet Earth. The course focuses on solid-state equilibria, liquid-solid phase equilibria, crystallography, and spatial associations. The module serves as preparation for subsequent modules on related topics and for field-based modules, including Advanced Geological Mapping, Advanced Geochemistry, the Research dissertation, the Alps field course, Advanced Petrogenesis.				
Pre-requisite(s):	Before taking this module you must pass ES2002			
Learning and teaching methods of delivery:	**Weekly contact**: 2 x 1-hour lectures (x 10 weeks), 3-hour practicals most weeks.			
	Scheduled learning: 50 hours		**Guided independent study:** 100 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 50%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 50%, 2 x 2-hour Practical Examination = 50%			
Re-assessment pattern:	2-hour Written Examination = 80%, Coursework = 20%, No Re-assessment if Coursework mark is less than 4			
Module coordinator:	Dr S Mikhail			
Module teaching staff:	Dr S Mikhail, Prof A Finch, Prof R White			

ES3011 Global Biogeochemical Cycles

SCOTCAT Credits:	15	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	To be arranged.			
Environmental Earth Science is inherently multi-disciplinary, but many environmental science courses focus on specific reservoirs of the Earth system (e.g., the atmosphere, oceans, or continental crust), rather than examining the system as a whole. The study of global biogeochemical cycling crosses these disciplinary boundaries, following specific elements as they are cycled through the Earth surface by physical, chemical, and biological transformations. This module will focus on the cycling of the five elements critical to life on Earth - carbon, oxygen, sulfur, phosphorus, and nitrogen - using examples from both modern and ancient environments and their response to human influence. An emphasis will be placed on the proxies utilised for unravelling these processes in the environment and in the rock record, along with modern quantitative methods used to constrain these cycles.				
Pre-requisite(s):	Before taking this module you must take ES2002 or take ES2003 and take ES3008			
Learning and teaching methods of delivery:	**Weekly contact**: 2 hour x 8 weeks online lectures, 3 hour x 4 weeks online practicals, 2 hour x 3 weeks in person discussion sessions			
	Scheduled learning: 34 hours		**Guided independent study:** 116 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%			
	As used by St Andrews: Written Examination (run as internal test in Week 9) = 50%, Coursework = 50%			
Re-assessment pattern:	2-hour Written Examination = 80%, Coursework = 20%, No Re-assessment if Coursework mark is less than 4			
Module coordinator:	Dr A L Zerkle			
Module teaching staff:	Dr A Zerkle, Dr M Claire, Dr S Mikhail			

ES3020 Global Climate Change

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	Lecture (9am Wednesday), Practical (2pm Tuesday), IT room (weeks 1 to 7)			
Climate change is one of the most challenging environmental problems currently facing society. Recent global warming likely lies outside the range of natural variability when compared to the last 1000 or even 2000 years. However, temperature is not the only game in town, and there are significant changes in hydro-climatic variability and related perturbations in large scale dynamical processes. This module provides fundamental information on climate dynamical processes and how we study them - currently and in the past. The module examines both strengths and limitations of terrestrial and marine proxy climate records used to study past climate of the late Holocene and Quaternary as well as introducing students to the fundamentals of modelling the climate system.				
Pre-requisite(s):	Before taking this module you must pass ES2001 and pass ES2002 and pass ES2003			
Learning and teaching methods of delivery:	**Weekly contact**: 2 hr x 10 weeks lectures; 3 x 10 weeks practicals			
	Scheduled learning: 50 hours		**Guided independent study:** 100 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%			
	As used by St Andrews: 2-hour Written Examination = 50%, Coursework = 50%			
Re-assessment pattern:	Retake Examination = 100%			
Module coordinator:	Professor R J S Wilson			
Module coordinator Email:	rjsw@st-andrews.ac.uk			
Module teaching staff:	Dr R Wilson, Dr A Burke, Dr J Rae, Dr M Byrne			

ES3099 Field Methods in Geosciences

SCOTCAT Credits:	30	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Available only to visiting students.			
Planned timetable:	none - field-based module.			
This module is designed exclusively for non-graduating overseas undergraduate students seeking advanced training in geological field methods. It consists of hands-on experience honing observational and mapping skills by participating in focused residential and one-day excursions, associated laboratory classes and at least one week-long residential course. The module takes full advantage of the University's location close to classic geological locations such as the NW Highlands region including the Moine thrust system, the Buchan and Barrovian metamorphic zones in the Dalradian terrane, and the Carboniferous sequences of NE England and Fife. The residential excursion normally includes the Sierra Norte region of central Spain, but location may vary.				
Pre-requisite(s):	Must be studying Earth Science at an overseas university			
Learning and teaching methods of delivery:	**Weekly contact**: Occasional lectures, tutorials and practicals in addition to fieldwork - this is predominantly a residential field-based module.			
	Scheduled learning: 192 hours		**Guided independent study:** 83 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available			
Module coordinator:	Dr W McCarthy			
Module teaching staff:	Earth and Environmental Sciences staff			

ES4001 Field Excursion and Map Interpretation

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	12 days fieldwork in August - September. 9.00 am - 5.00 pm Fri (practicals)			
This module develops the field observation and interpretation skills of collecting, recording, interpreting and synthesising data in the field and from geological maps and cross-sections. The field course will be thematic, examining and synthesising all aspects of a region to interpret a complex geological history and geodynamical evolution of an orogenic belt. Theme and location may vary.				
Pre-requisite(s):	Before taking this module you must take ES3006			
Learning and teaching methods of delivery:	**Weekly contact**: 2-week field course and lab sessions.			
	Scheduled learning: 96 hours		**Guided independent study:** 64 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor A R Prave			
Module teaching staff:	Earth and Environmental Sciences staff			

ES4002 Research Review, Essay and Seminar

SCOTCAT Credits:	15	SCQF level 10	**Semester**	Both
Academic year:	2020-2021			
Availability restrictions:	BSc students may only take this module in Semester 1, MGeol students can take this module in either semester. Available to General Degree students with the permission of the Honours Adviser			
Planned timetable:	Not applicable.			
The student proposes a geoscience or environmental science topic that has not been directly covered in a taken module. They discuss the suitability of the topic with a staff member who agrees to become adviser to the student. Student and adviser are required to meet 2 further times during the module. Research of the peer-reviewed literature is conducted and the student writes a critical review of ca. 3,000 words, developing their own ideas and critically evaluating data. The same material is also presented in a 10 minute seminar to staff and classmates. Advice on critical writing and presenting talks is given a year before the start of the module, on entry to Junior Honours, for use throughout the Honours programme. The seminar is assessed by multiple staff.				
Pre-requisite(s):	Admission to an Honours Earth Sciences programme or Environmental Earth Science			
Learning and teaching methods of delivery:	**Weekly contact**: Occasional lecture and ca. 3 meetings with adviser spread across the semester.			
	Scheduled learning: 10 hours		**Guided independent study:** 140 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 15%, Coursework = 85%			
	As used by St Andrews: Practical Examination = 15%, Coursework = 85%			
Re-assessment pattern:	Oral Examination = 100%			
Module coordinator:	Dr C R Cousins			
Module teaching staff:	Earth and Environmental Sciences staff			

ES4003 Research Dissertation

SCOTCAT Credits:	45	SCQF level 10	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to Single Honours BSc Earth Science students			
Planned timetable:	Not applicable.			
An individual research project which allows the student to pursue in depth a topic of personal interest. The student works largely independently of supervision and has the opportunity to demonstrate individuality, initiative and creativity. Skills of planning and executing research are learnt, as well as the ability to work independently, and present the results orally and in dissertation form (up to 10,000 words). BSc Geology dissertation projects include a minimum of 18 days independent geological mapping. (Guidelines for printing and binding dissertations can be found at: http://www.st-andrews.ac.uk/printanddesign/dissertation/)				
Pre-requisite(s):	Admission to an Honours Earth Sciences programme or Environmental Earth Science			
Learning and teaching methods of delivery:	**Weekly contact**: Mostly online delivery: No lectures, catch-up sessions online, independent research project 1 x 3 weeks practical session: Oral and Poster presentation, Mock Interview			
	Scheduled learning: 20 hours		**Guided independent study:** 430 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 10%, Coursework = 90%			
	As used by St Andrews: Proposal = 5%, Oral presentation = 10%, Dissertation = 85%			
Re-assessment pattern:	No Re-assessment available			
Module coordinator:	Dr C R Cousins			
Module teaching staff:	Earth and Environmental Sciences staff			

ES4007 Petroleum Exploration and Geophysics

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	11.00 am - 1.00 pm Thu (lectures), 2.00 - 5.00 pm Thu (practicals)			
The fundamental concepts, techniques and practices of the hydrocarbon exploration industry are presented. Students will gain a thorough understanding of the geoscience of petroleum exploration, particularly using geophysical methods, and a working knowledge of modern concepts in oil and gas geology.				
Pre-requisite(s):	Before taking this module you must pass ES2001 and (pass ES2002 or pass ES2003)			
Learning and teaching methods of delivery:	**Weekly contact**: 19 lectures and 4 workshops, 2 practicals and support sessions (Weeks 1 - 10). All lectures will be given using Panopto and be recorded. Practical classes will be delivered in the IT classroom suite and also be available through remote login to the Irvine IT labs.			
	Scheduled learning: 54 hours		**Guided independent study:** 99 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework (Petrel Logging - 50%, Carbonate Workshop - 20%, Wireline Logging Workshop - 10%, North Sea Report - 20%) = 100%			
Re-assessment pattern:	Current Coursework (Petrel Logging) = 50%, Coursework = 50%, No Re-assessment if Coursework mark is less than 4			
Module coordinator:	Dr C R Bates			
Module teaching staff:	Dr R Bates			

ES4008 Environmental Excursion

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Available to General Degree students with the permission of the Honours Adviser			
Planned timetable:	6 days fieldwork preceding Senior Honours. 9.00 am - 5.00 pm Fri (practicals)			
This module is designed to provide advanced field-based training in a variety of environmental and geochemical analytical techniques of utility to solving geo-environmental problems. The field course will be thematic and examine environmental aspects of a region using an integrated approach. Theme and location may vary. Additional post-trip analyses may include GIS and laboratory work.				
Pre-requisite(s):	Before taking this module you must pass ES3006			
Learning and teaching methods of delivery:	**Weekly contact**: 6 day field course with lab sessions.			
	Scheduled learning: 60 hours		**Guided independent study:** 90 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr A Burke			
Module teaching staff:	Dr A Burke, Dr J Rae			

ES4011 Work Placement in Earth Sciences

SCOTCAT Credits:	30	SCQF level 10	**Semester**	Both
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged.			
Practical experience of Earth Sciences is important to graduate job prospects and for students to understand the practical relevance of taught material course. This module is a platform for the students to obtain experience of the workplace through an 8-week industrial placement. The student finds their own work placement, some with the assistance of staff connections in industry and alumni. Work placements can be of a variety of forms, varying from office or lab-based work to engineering geology at sites in the UK to exploration geology across the world. The performance of the student in the workplace is assessed using similar criteria to those used when applying for Chartered (CGeol) status. The student reports on their activities during placement at the end of the placement period.				
Pre-requisite(s):	Students must be enrolled on the MGeol Earth Sciences programme.			
Learning and teaching methods of delivery:	This is a Study Abroad or External Placement module			
	Weekly contact: Meetings.			
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 30%, Coursework = 70%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available			
Module coordinator:	Professor A A Finch			
Module teaching staff:	Earth and Environmental Sciences staff			

ES4012 Research Placement in Earth Sciences

SCOTCAT Credits:	30	SCQF level 10	**Semester**	Both
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged.			
Practical experience of Earth Sciences is important to graduate job prospects and for students to understand the practical relevance of taught material in the course. The present module is a platform for the students to obtain experience of the working in an academic research team through a research placement. The student finds their own placement by negotiating with staff. The performance of the student in the workplace is assessed using similar criteria to those used when applying for a PhD. The student reports on their activities during placement at the end of the placement period.				
Pre-requisite(s):	Students must be enrolled on the MGeol Earth Sciences programme.			
Learning and teaching methods of delivery:	This is a Study Abroad or External Placement module			
	Weekly contact: Meetings.			
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available			
Module coordinator:	Professor A A Finch			
Module teaching staff:	Earth and Environmental Sciences staff			

ES4013 Field Mapping Skills

SCOTCAT Credits:	30	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Only available to MGeol students			
Planned timetable:	To be confirmed			
The ability to collect field geological data and to interpret them are key skills required of any Earth Sciences graduate. It is also a key requisite of Geological Society of London accredited programmes. This module requires the candidate to identify an area of geological interest and to take responsibility for the logistical and H and S requirements of performing a field visit. The candidate then will map independently the solid and/or Quaternary geology and to summarise the field data in the form of a notebook, geological map and a short memoir. The candidate is at liberty to choose an area and a supervisor that resonate with their own interests in Earth Sciences. At the end of the module, the candidate will have demonstrated their skills in the collection and interpretation of field geology. Such skills can then underpin careful lab-based studies (such as geochemistry or geophysics) in subsequent project (e.g. dissertation) work.				
Pre-requisite(s):	Before taking this module you must pass ES3006			
Learning and teaching methods of delivery:	**Weekly contact**:			
	Scheduled learning: 286 hours		**Guided independent study:** 0 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: 100% Coursework			
Re-assessment pattern:	100% Coursework			
Module coordinator:	Dr C R Cousins			
Module teaching staff:	All of the academic staff will supervise one or two students			

ES4020 Special Topics in Climate Science

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	Lecture (Tuesday 2pm), Practical (Thursday 2pm)			
Climate change is one of the most urgent scientific problems of our day. As a result there has been a large effort to further the understanding of climate dynamics, climate forcings and sensitivities, and past climate changes to improve our knowledge of the climate system and our ability to project future climate change. This course will tackle a variety of topical research subjects in climate science, such as ENSO, climate sensitivity, hydroclimate variability in a warmer world, paleo-hydroclimate, past warm climates, external forcing of climate, and geo-engineering.				
Pre-requisite(s):	Before taking this module you must pass ES2001 and pass ES2002 and pass ES2003			
Learning and teaching methods of delivery:	**Weekly contact**: 1 hour lectures (9 weeks), 3 hours seminars (9 weeks)			
	Scheduled learning: 39 hours		**Guided independent study:** 110 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 60%, Coursework = 40%			
	As used by St Andrews: Coursework = 40%, Practical Examination 60%			
Re-assessment pattern:	Written Examination = 100%			
Module coordinator:	Dr A Burke			
Module teaching staff:	Dr Andrea Burke, Dr M Byrne, Dr J Rae, Dr R Wilson			

ES5001 Expedition Field Course

SCOTCAT Credits:	15	SCQF level 11	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Only available to MGeol students			
Planned timetable:	To be arranged.			
Fieldwork in Earth Sciences is key to graduate job prospects and is a platform for students to bring together the many aspects of Earth Sciences. The present module will involve the students not just in carrying out fieldwork, but also in the logistical and interpersonal sides of successful fieldwork design. Students will identify a field area for study in consultation with a member of the teaching staff, which includes several aspects of Earth sciences, such as igneous, sedimentary, economic and environmental geology. The students will form a team and divide the responsibilities for fieldwork and logistics. The assessment will include a memoir that will summarise the geological history of the area, similar to that published by a Geological Survey or the exploration industry. A (formatively assessed) presentation may be required if funding was provided by an external body. Some student groups may choose to use this module to carry out ambitious fieldwork in a remote setting.				
Pre-requisite(s):	Entry to Year 5 of MGeol Earth Sciences			
Learning and teaching methods of delivery:	**Weekly contact**: 5 hours of orientation/tutorials over 2 weeks			
	Scheduled learning: 10 hours		**Guided independent study:** 140 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	Oral Examination = 100%			
Module coordinator:	Dr S Mikhail			

ES5003 Research Dissertation

SCOTCAT Credits:	60	SCQF level 11	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged.			
This course includes an individual research project on a topic in geological, planetary or environmental sciences and allows the student to pursue a topic of personal interest. The student works largely independently of supervision and has the opportunity to demonstrate individuality, initiative and enterprise.				
Pre-requisite(s):	Students must be in Year 5 of the MGeol Earth Sciences programme			
Learning and teaching methods of delivery:	**Weekly contact**: Regular meetings with supervisor arranged as required.			
	Scheduled learning: 30 hours		**Guided independent study:** 570 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100% (Project proposal = 5%, Oral Presentation = 10%, Dissertation = 85%)			
Re-assessment pattern:	No Re-assessment available			
Module coordinator:	Dr S Mikhail			
Module teaching staff:	Earth and Environmental Sciences staff			

ES5005 Isotope Geochemistry: Theory, Techniques, and Applications

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged.			
Isotope geochemistry has grown over the last 50 years to become one of the most important fields in the Earth sciences. The growth in the importance of isotope geochemistry reflects its remarkable success in solving fundamental problems in mantle formation, ore genesis, hydrology, hydrocarbon formation, crustal evolution, planetary formation, geochemical cycles, hydrothermal circulation, ocean circulation, and climate and environmental change. In this module, we will explore the theory of isotopes and their fractionation, including kinetic, equilibrium, and Rayleigh fractionation. We will also use case studies and applications of isotopes to interesting problems across Earth Sciences including the evolution of the atmosphere, the formation of the solar system and planets, and climate and carbon cycle reconstructions. These case studies will introduce concepts such as clumped isotopes, isotope mass balance, mass independent fractionation, and radionuclide disequilibria.				
Pre-requisite(s):	Current BSc Students SHOULD PASS ES3008 or pass (ch1401, CH1402 and CH2501)			
Learning and teaching methods of delivery:	**Weekly contact**: 14 x 1 hour lectures, 2 x 3 hour online practicals, 1 x 3 hour in person practical, 6 x 1 hour in person discussions			
	Scheduled learning: 29 hours		**Guided independent study:** 121 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 50%, Coursework = 50%			
	As used by St Andrews: 2-hour Practical (Open Book) Examination = 50%, Coursework = 50%			
Re-assessment pattern:	2-hour Practical (Open Book) Examination = 80%, Coursework = 20%			
Module coordinator:	Dr A Burke			
Module teaching staff:	Dr A Burke, Dr P Savage, Dr A Zerkle			

ES5010 Advanced Geochemistry

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged.			
The objective of this course is to provide students with skills in some of the more advanced topics in geochemistry that are not commonly discussed in introductory courses, such as geochemical processes in 'extreme' environments, aqueous geochemical modeling, or organic geochemistry. The selection of topics covers both theoretical and applied aspects in geochemical sciences with the aim of laying out potential avenues for future professional development.				
Pre-requisite(s):	Before taking this module you must take ES3008			
Learning and teaching methods of delivery:	**Weekly contact**: 33 hours in total over the semester, composed of a combination of lectures and 2-3 hour practicals.			
	Scheduled learning: 33 hours		**Guided independent study:** 117 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 30%, Coursework = 70%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	2-hour Written Examination = 80%, Coursework = 20%, No Re-assessment if Coursework mark is less than 4			
Module coordinator:	Dr E E Stueeken			
Module teaching staff:	Other SEES staff and/or external lecturers			

ES5011 Water in the Environment

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged.			
This module provides an introduction to hydrogeology (the distribution and movement of water through rocks and soils) and water quality and contamination. In the module we study the theory and concept of hydrology and groundwater flow, how to model fluid flows and how to predict solute and contaminant transport. We study key aqueous pollutants (e.g. metals, radionuclides, nutrients), their behaviour in different waters (speciation, mobility, bioavailability and toxicity) and methods of remediation.				
Pre-requisite(s):	Undergraduate students without the prerequisite but with a suitable Chemistry background should be considered. Before taking this module you must pass ES3008			
Learning and teaching methods of delivery:	**Weekly contact**: Total of 16 hours of lectures, 12 hours of practicals, one field trip and interviews.			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 40%, Practical Examinations = 15%, Coursework = 45%			
	As used by St Andrews: 2-hour Written Examination = 40%, Coursework (including Technical Brief, Media Interview and Qualitative analysis exercise) = 60%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr N Allison			
Module teaching staff:	Dr N Allison, Mr A Black (Groundwater Science Ltd)			

ES5013 Advanced Petrogenesis

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10.00 am Mon and Tue (lectures). 10.00 - 1.00 pm Wed or Fri (practicals)			
Requested Correction Rocky planets, like Earth, comprise of a metallic core with a rocky mantle and crust topped with a gaseous atmosphere. The focus of this course is the genesis of the rocky mantle and crust, termed the silicate Earth, and its relationship to small-scale to planetary-wide processes. The silicate Earth primarily comprises igneous and metamorphic rocks. This module explores the nature of the magmatic and metamorphic processes that characterise the Earth from the immediate subsurface to the base of the mantle. We focus on the petrology and geochemistry of the minerals and rocks created, and the evolution of composition as a function of time and depth. Students completing this module will understand how magmatic systems operate from melting source, through ascent to the plumbing systems in the immediate subsurface. The response of the crust to dynamic changes in pressure and temperature will also be explained along with the methods used to determine these. The course will develop key skills in identifying rocks, interpreting geochemical data, and using geochemical and thermodynamic methods to unravel rock histories. Students will also be shown how these data can be used to understand any and all rocky bodies in the cosmos, from Earth to exoplanets.				
Pre-requisite(s):	Before taking this module you must take ES3009			
Learning and teaching methods of delivery:	**Weekly contact**: 19 lectures, 15 hours of laboratory work, 18 hours of field-related study over the semester			
	Scheduled learning: 50 hours		**Guided independent study:** 100 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 50%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 50%, 3-hour Practical Examination = 50%			
Re-assessment pattern:	2-hour Written Examination = 100%, No Re-assessment if Coursework mark is less than 4			
Module coordinator:	Professor A A Finch			
Module teaching staff:	Prof A Finch, Prof R White and Dr S Mikhail			

ES5031 Statistics and Analytical Sciences

SCOTCAT Credits:	5	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	To be confirmed			
This module is designed to provide MSc Geochemistry students with a strong background in Statistics and methods of data analysis used in Earth Sciences. The module comprises a series of combined lecture-practical classes. These will cover both statistical concepts (distributions, accuracy and precision, error propagation, Monte Carlo simulations etc.) and applied data manipulation (using spreadsheets and the statistical programming language R). Weekly practical classes will put the lecture material into a practical context and comprise 40% of the module grade. Students will undertake a data analysis and modelling project which will comprise 60% of the module grade. The module will give students the necessary training to allow them to excel in their own data analysis during their Research Dissertations.				
Learning and teaching methods of delivery:	**Weekly contact**: 1 hour x 8 weeks online lectures, 2 hourr x 8 weeks online practicals			
	Scheduled learning: 24 hours		**Guided independent study:** 24 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	Coursework = 100%			
Module coordinator:	Dr R C J Steele			
Module teaching staff:	Dr Robert Steele			

ES5050 Earth's Greatest Hits

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Available to General Degree students with the permission of the Honours Adviser			
Planned timetable:	Lecture - Thursday, Practical - Wednesday			
This module is based around current hot topics in Earth science research. It will introduce cutting-edge science questions about how our planet has evolved from a ball of molten rock to the habitable blue planet it is today, and some of the major changes in its chemistry, biosphere, and climate that have happened along the way. Topics will vary from year to year, depending on staff participating in the module and the advances in Earth science research. This module is research-led, requiring that you read, digest, and discuss a number of topical papers each week. For some of these topics there is no given answer; instead you gain an in-depth understanding of the current state of research. Topics are introduced in lectures and then discussion seminars, organised around student presentations, are designed to encourage debate and critique of the arguments presented in the research papers.				
Pre-requisite(s):	Undergraduate Students SHOULD PASS ES2001 AND PASS ES2002 AND PASS ES2003			
Learning and teaching methods of delivery:	**Weekly contact**: 8 hours of lectures and 24 hours of seminars over the semester.			
	Scheduled learning: 30 hours		**Guided independent study:** 120 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 60%, Coursework = 40%			
	As used by St Andrews: Practical Examination (Oral Presentations) = 60%, Written Examination = 40%			
Re-assessment pattern:	Written Examination = 100%			
Module coordinator:	Dr J W B Rae			
Module teaching staff:	Dr James Rae + other SEES staff			

ES5300 Core to Crust Ore Genesis - High Temperature

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
This module explores ore deposits that form in high-temperature environments, extending from mantle processes to the upper crust. Current genetic models of ore deposits are reviewed with an emphasis on the geological processes required to create them. Deposit types discussed may include some or all of diamond formation, magmatic Ni-Cu and PGE-Cr, Cu and Sn porphyry, skarn, Rare Earth Element (REE) and iron oxide copper gold (IOCG). Laboratory exercises involve geological problem solving using a mineral exploration industry focus involving the examination of representative suites of samples.				
Pre-requisite(s):	Acceptance to year 5 of a M-level programme in the School of Earth & Environmental Sciences			
Learning and teaching methods of delivery:	**Weekly contact**: 1 lecture x 10 weeks, 1 seminar x 10 weeks, 1 practical x 4 weeks			
	Scheduled learning: 32 hours		**Guided independent study:** 116 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 50%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 50%, Practical Examination = 50%			
Re-assessment pattern:	2-hour Written Examination = 80%, Practical Examination = 20%			
Module coordinator:	Professor A A Finch			
Module teaching staff:	Prof A Finch and Dr N Gardiner			

ES5302 Core to Crust Ore Genesis - Low Temperature

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Enrolment is limited to MSc students in Mineral Resources and Geochemistry and to MGeol students			
Planned timetable:	To be arranged			
This module explores ore deposits that form in low-temperature environments, extending from the upper crust to the critical zone at Earth's surface, including topics such as physical and chemical properties of hydrothermal fluids, volcanogenic and sedimentary sulphide deposits, iron manganese oxides, evaporites, and soil-hosted ores. The material will be delivered through a combination of lectures and hands-on practicals.				
Pre-requisite(s):	Student must have gained entrance to the mgeol or msc mineral resources or geochemistry programmes			
Learning and teaching methods of delivery:	**Weekly contact**: Each week includes 2 lectures (x 10 weeks) and 1 practical (x 8 weeks) or 1 seminar (x 2 weeks)			
	Scheduled learning: 50 hours		**Guided independent study:** 100 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 20%, Coursework = 30%			
	As used by St Andrews: Written Examination (run as internal test in Week 9) = 50%, Coursework = 30%, Practical Examination = 20%			
Re-assessment pattern:	Practical Examination = 100%			
Module coordinator:	Dr E E Stueeken			
Module teaching staff:	Dr E. Stueeken and other SEES staff			

ES5304 3D Geological Modelling

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Available only to students on the MGeol or Mineral Resources degrees			
Planned timetable:	To be arranged.			
This module aims to familiarise students with three-dimensional geological modelling using the industry-standard pieces of software. The module emphasises the creation, validation and interpretation of geological and structural models, as well as their use in mineral exploration and mineral resource estimation. Module assessment is based on the quality of three-dimensional models created and group participation.				
Learning and teaching methods of delivery:	**Weekly contact**: 3 hours of lectures (x 5 weeks), 3 hours of practical classes (x 5 weeks)			
	Scheduled learning: 30 hours		**Guided independent study:** 120 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available			
Module coordinator:	Dr N J Gardiner			
Module teaching staff:	Dr Nick Gardiner and other SEES staff			

ID4442 Combined Research Project in Biology and Geology

SCOTCAT Credits:	45	SCQF level 10	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Student must be enrolled on the Joint Biol-Geology degree			
Planned timetable:	To be arranged.			
This module provides an individual research project on a topic spanning the biological and geological sciences which allows the student to pursue in depth a topic of personal interest. The student works largely independently of supervision and has the opportunity to demonstrate individuality, initiative and enterprise. The project will be supported by advisors in both Biology and Geology. Skills of planning and executing research are learnt, as well as the ability to work independently, and present the results orally and in dissertation form (up to 10,000 words). (Guidelines for printing and binding dissertations can be found at: http://www.st-andrews.ac.uk/printanddesign/dissertation/)				
Pre-requisite(s):	Admission to BSc Honours programme in Biology and Geology			
Learning and teaching methods of delivery:	**Weekly contact**: Individual supervision by member(s) of teaching staff			
	Scheduled learning: 20 hours		**Guided independent study:** 430 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 10%, Coursework = 90%			
	As used by St Andrews: Research proposal = 5%, Oral Presentation = 10%, Dissertation = 85%			
Re-assessment pattern:	No Re-assessment available			
Module coordinator:	Dr T D Raub			
Module teaching staff:	Dr T Raub			