The University of Edinburgh
School of GeoSciences

BSc / MEarthPhys Geophysics
BSc / MEarthPhys Geophysics and Geology
BSc / MEarthPhys Geophysics and Meteorology

Years 1 and 2 – Pre-honours

2017/18 Course Information

Contents

Introduction

This handbook describes the courses taught in the first two years (the *pre-honours* years) of the Geophysics degrees at the University of Edinburgh. Many of the courses are common to other Earth Science-related degree programmes. A synopsis of each individual course is given in this handbook.

This handbook also includes details of timetables for each course, the number of credits you are expected to achieve in the pre-honours years of your degree programme and details of learning outcomes for each course.

The details contained in the handbook are correct at the time of publishing.

Dr Hugh Pumphrey
Degree Programme Convenor
Geophysics degrees.

Geophysics degrees: Year 1

There are three different variants of the geophysics degree at Edinburgh:

Geophysics (single subject)
Geophysics and Meteorology
Geophysics and Geology

The first year is the same for all three variants, with each semester consisting of one mathematics course, one physics course and one Earth science course. There are no options in the first year; this is because you need to learn the same mathematics and physics as a Physics undergraduate, but you also need to learn some Earth science. The courses you will take are:

	Earth science courses	Physics courses	Maths courses
Semester 1	EASC08001 Earth Dynamics	PHYS08016 Physics 1A	PHYS08035 Maths for Physics 1
Semester 2	EASC08008 Introduction to Geophysics	PHYS08017 Physics 1B	PHYS08036 Maths for Physics 2

Degree changes at the end of Year 1

Although there is no flexibility of course choices within year 1, there is a considerable amount of flexibility of degree programme at the end of it. Any change of degree programme must be done between academic years (the deadline is in week 2 of the first semester – Friday 30th September). Changes of degree within the School require the permission of the degree programme convenor of the degree to which you are changing. Changes of degree outwith the School require permission from the College of Science and Engineering.

Changes from one geophysics degree to another.

As the first year is common to all three geophysics variants there are no barriers to changing between them before the start of the second year.

Change to Geology, GPG or Environmental GeoSciences

These changes are straightforward at the end of the first year but require permission from the relevant degree programme convenor.

Changes to Physics

The first year of the geophysics degrees is compatible with the first year of most (if not all) physics degrees. If you get good enough grades in the first-year maths and physics courses then this change is possible but requires consent from the School of Physics and Astronomy and from the College of Science and Engineering

Geophysics degrees: Year 2

In the second year the three geophysics degrees diverge considerably from each other. There are common mathematics and physics courses in semester 1, but geophysics and meteorology students have a compulsory meteorology course. Geophysics and geology students have a compulsory geology course. All variants have one optional course and the single-subject degree has two. In semester 2, all geophysics students take Physics of the Earth but the rest of the programme includes further specialisations for the three variants. The courses taken are as follows:

	Geophysics	Geophysics and Meteorology	Geophysics and Geology
Semester 1	PHYS08045 Modern Physics PHYS08042 Lin Alg + SVC 2 optional Courses	PHYS08045 Modern Physics PHYS08042 Lin Alg + SVC METE08001 Met: Atm+Env 1 optional course	PHYS08045 Modern Physics PHYS08042 Lin Alg + SVC EASC08014 Geomaterials 1 optional course
Semester 2	EASC08016 Physics of the Earth EASC08020 Global Tectonics & The Rock Cycle PHYS08043 Dynamics and Vector Calculus	EASC08016 Physics of the Earth PHYS08043 Dynamics and Vector Calc. METE08002 Met:Weath+Clim	EASC08016 Physics of the Earth EASC08019 Global Tect + Rock Cyc. EASC08017 Introduction to the Geol. Record

Note that PHYS08045 and PHYS08042 are worth 10 credits each. All other courses are worth 20 credits.

Geophysics degrees: Direct entry into year 2

It is possible for students to enter the second year directly from School, if their grades are good enough. Typically, we require AAA at advanced higher, A*AA at A-level, and a similar level of performance in other qualifications, and/or an excellent score in the diagnostic maths test. Semester 2 is identical for direct entry students and those who went through the first year. Semester 1 for direct entry students is as follows:

	Geophysics	Geophysics and Meteorology	Geophysics and Geology
Semester 1	EASC08022 Earth Science Fundamentals for Geophysicists PHYS08041 Algebra and Calculus PHYS08055 Classical Physics 1 optional Courses	EASC08022 Earth Science Fundamentals for Geophysicists PHYS08041 Algebra and Calculus PHYS08055 Classical Physics METE08001 Met: Atm+Env	EASC08022 Earth Science Fundamentals for Geophysicists PHYS08041 Algebra and Calculus PHYS08055 Classical Physics EASC08014 Geomaterials

Students entering the second year of the geophysics degree from the first year of a different degree may be required to follow a variant of this schedule, depending on the courses taken in their first year.

Suggested optional courses

Your optional course (or courses) can be any level 8 course run by any school within the University (apart from Medicine or Vet. Medicine). However, your choice is restricted by timetable clashes and by the fact that some courses may only be able to accept limited numbers of students. And you may wish to solidify your Earth sciences / Physics education by choosing courses in those areas. Courses which appear to work in this year's timetable include:

- METE08001 Meteorology: Atmosphere and Environment (Geophysics and Meteorology students have to take this)

- EASC08014 Geomaterials (Geophysics and Geology students have to take this)
- PHYS08039 Discovering Astronomy OR PHYS08051 Astrobiology (these clash with each other. For Single subject and +Meteorology only as these courses clash with Geomaterials)
- PHYS08021 Musical Acoustics (Clashes with Geomaterials)
- INFR08022 Computer Programming Skills and Concepts (Lecture clash with Geomaterials)
- GEGR08007 Human Geography
- ARCA08004 Archaeology 1A
- GEGR08001 Environmental Sensitivity and Change
- BILG08001 Origin and Diversity of Life

(Courses which sadly have a clash with your compulsory subjects include EASC08011 Natural Hazards, EASC08023 Evolution of the Living Earth and ECSC08006 Principles of Ecology.) Some of the courses listed above may not be accessible to single-subject geophysics students entering the second year directly from School.

Changes of degree during the year

You may not make a formal change of degree during the year. However, if you make the right course choices you may decide at Christmas to change degree, register for the right courses for the degree you are changing to in semester 2, and then make the formal change of degree at the end of year 2.

- If you choose METE08001 Meteorology: Atmosphere and Environment, you may make the decision to change to Geophysics and Meteorology at the end of semester 1.
- If you choose EASC08014 Geomaterials you may make the decision to change to Geophysics and Geology at the end of semester 1
- You may change from either of the joint degrees to the single-subject geophysics degree at the end of semester 1

Any other change of degree made at the end of the second year will almost certainly require that you take an extra pre-honours year.

Course summary

The table below contains brief details of each course in the Geophysics degree programme tables. Further details of each course are found later in this guide.

Compulsory courses

Course Code	Course Title	Course Organiser	Course Secretary	Year	Semester	Credits
EASC08001	Earth Dynamics	Dr Cees-Jan De Hoog	Mrs. Nicola Clark	1	1	20
EASC08008	Introduction to Geophysics	Prof Wyn Williams	Mrs. Nicola Clark	1	2	20
PHYS08016	Physics 1A: Foundations	Dr Ross Galloway	Miss Rhona Johnson	1	1	20
PHYS08017	Physics 1B: The Stuff of the Universe	Dr Ross Galloway	Miss Rhona Johnson	1	2	20
PHYS08035	Mathematics for Physics 1	Dr Kristel Torokoff	Miss Rhona Johnson	1	1	20
PHYS08036	Mathematics for Physics 2	Dr Kristel Torokoff	Miss Rhona Johnson	1	1	20
EASC08016	Physics of the Earth	Dr Mark Naylor	Mrs. Nicola Clark	2	1	20
EASC08020§	Global Tectonics and the Rock Cycle	Jennifer Tait	Mrs. Nicola Clark	2	2	20
PHYS08043**	Dynamics and Vector Calculus	Prof Stephen Playfer	Mrs Bonnie Macmillan	2	2	20
EASC08017*	Introduction to the Geological Record	Kate Saunders	Mrs. Nicola Clark	2	2	20
EASC08021*	Geomaterials	Dr Tetsuya Komabayashi	Mrs. Nicola Clark	2	1	20
PHYS08045	Modern Physics	Prof Alex Murphy	Mr Peter Hodkinson	2	1	10

PHYS08042	Linear Algebra and Several Variable Calculus	Dr Philip Clark	Mrs Bonnie Macmillan	2	1	10
METE08001†	Meteorology: Atmosphere and Environment	David Stevenson	Ms. Christine Lee	2	1	20
METE08002†	Meteorology: Weather and Climate	Dr Ruth Doherty	Miss Christine Lee	2	2	20

* Courses specific to BSc Geophysics and Geology degree

† Courses specific to BSc Geophysics and Meteorology degree

§ Not taken on BSc Geophysics and Meteorology degree

** Not taken on BSc Geophysics and Geology degree

Contact details for Course Organisers and Course Secretaries are included in the detailed descriptions of each course, found later in this guide.

Key Dates

The table below details key University and School dates throughout the 2016/17 academic year. These dates are correct at the time of publishing and may be subject to change.

2017

11th – 15th September	Welcome Week (http://www.ed.ac.uk/students/new-students/events)
TBC	Welcome talk (11:10 – 12:00)
TBC	Careers Presentation (10.30 – 11.00)
18th September	Start of Teaching Block 1
TBC	Student Staff Liaison Committee meeting
20th October	End of Teaching Block 1
23rd October	Start of Teaching Block 2
TBC	Winter Exam diet timetable published
TBC	Student Staff Liaison Committee meeting
TBC	Graduations start
TBC	Student Staff Liaison Committee meeting
	School of GeoSciences graduation ceremony
	Graduations end
1st December	End of Teaching Block 2
	Revision
	Examinations start
22nd December	End of Semester 1/End of Examinations

2018

12th January	Winter Teaching Vacation ends
15th January	Start of Teaching Block 3
TBC	Student Staff Liaison Committee meeting
16th February	End of Teaching Block 3
TBC	Innovative Learning Week
26th February	Start of Teaching Block 4
TBC	Spring Exam diet timetable published
TBC	Student Staff Liaison Committee meeting
6th April	End of Teaching Block 4
9th April	Spring Teaching Vacation starts
20th April	Spring Teaching Vacation ends
23rd-27th April	Revision week
	Examinations start
	End of Semester 2/End of Examinations
	Summer Teaching Vacation starts
TBC	Graduations start
TBC	School of GeoSciences graduation ceremony
TBC	End of Graduations

Course submission deadlines can be viewed on the Teaching Organisation Deadline Diary at http://www.ed.ac.uk/schools-departments/geosciences/teaching-organisation/to-overview

Compulsory Course Information

Course Information

EASC08001 Earth Dynamics

Course Organiser:	CEES-JAN DE HOOG	**Other Key Staff:**	JENNY TAIT; IAN MAIN; GODFREY FITTON; STUART HASZELDINE
Course Secretary:	NICOLA CLARK	**Course location:**	Central/Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description

Volcanoes, earthquakes, mountain chains and the diversity of the Earth's rocks tell us that the Earth has been a dynamic planet since its formation 4.6 billion years ago. This course has two main aims: to impart an understanding of the processes which shape the Earth, and to develop practical skills in recognising the evidence of these processes in rocks, both in the field and in the laboratory. The course will have a primary focus on the materials of which the Earth is made, how the major constituents are distributed between core, mantle and crust and how this changes with time through the agencies of plate tectonics and volcanism. Geological resources, from energy, to minerals, and water, are essential for all aspects of society. How these resources are categorised, and where they are they formed is part of our fundamental understanding of the Earth as an integrated system.

Learning Outcomes

Students will develop a broad understanding of key, defining geological concepts and theories: the internal divisions of the Earth and its dynamic evolution via plate tectonic processes, the formation of sedimentary, igneous and metamorphic rocks, the mechanisms by which rocks deform and break at depth in the Earth, and the dynamic geological settings in which these processes operate. This will be achieved through routine, geological techniques: laboratory practicals including hand specimen and thin section analysis, fieldwork and ICT exercises. These ICT exercises will involve interpretation of deep Earth processes from geophysical data sets and virtual fieldwork exercises. Practical classes will be the basis for investigating professional level problems and issues to formulate evidence-based solutions using the techniques listed above. During these practical sessions students are expected to manage their time effectively and work both independently and with others.

Assessment and Feedback information

http://www.ed.ac.uk/files/atoms/files/taughtassessmentregulations.pdf

All details related to extensions procedures and late penalties can be found in the:

School of GeoSciences General Information Handbook 2017-18

Opportunities for feedback

Feedback is the process of giving constructive comment to you so that you can improve your performance. During this course there is an opportunity for verbal feedback during all practical sessions. Your practical folders will be assessed twice during the course and comments made on the quality of work and where improvement is possible. There are also two field trips. After the first trip, formative feedback will be provided which can feed forward to your assessed notebook mark after the second field excursion. If at any point during the course you require clarity please contact the CO in the first instance.

Assessment details

Written Exam: 60%, Course Work: 40%, Practical Exam: 0%.

You must pass both components to obtain an overall pass

Course Work
The course work component includes your weekly practical workbooks as well as field trip attendance and notebook write up. The practical workbooks will be examined twice during the semester. The first practical mark will be based on work completed in selected sections the first set of practicals (Block 1, up to the end of Week 5), the second on work completed in selected sections of the second set of practicals (Block 2, practicals in Weeks 7-10). Your practical books will be submitted at our Assessment Submission Point (Grant Institute, Teaching Organisation Office) for marking mid-way through the semester (end of Week 5 to beginning of Week 6) and following your Week 10 practical. They will be marked within a week of submission and will be available for collection by you in time for your next practical or for end-of-semester revision. Incomplete practicals or practical workbooks, or absence from a practical where workbooks are marked, will be penalised unless you have special circumstances supported by doctor's note or letter from your Student Support Co-ordinator.
In addition to the practical workbook you are required to submit your field notebook for marking after each field trip. The second mark will contribute towards your overall 'practical' mark.

Written Exam (Theory Examination):
A two-hour theory exam based on short answers and multiple choice questions will be held at the end of Semester 1. Further information will be provided on this in due course. The Semester 1 Theory examination will be worth 60% of your final mark. The theory re-sit examination will be held in August 2018.

If you fail to pass both components at first attempt the following will happen:
Fail coursework, pass exam: Alternative coursework will be assigned which requires all exercises in the practical folder to be completed AND extra petrographic description work. Deadline to submit work to TO Grant Institute 1 pm March 28th, 2018. Exam mark stands no resit allowed.
Fail exam, pass course work: Resit exam in August exam diet; Coursework mark carried forward.
Fail exam, fail coursework: Resit exam in August exam diet; Alternative coursework to be completed including all exercises in the practical folder AND extra petrographic description work. Deadline to submit work to TO Grant Institute 1 pm March 28th, 2018.

Marks should be regarded as provisional until after the final examiner's meeting, which will be held in January 2018.

Assessment deadlines
Practical workbooks to be handed in after the practical during week 5 or week 6 depending on practical session as follows:
Monday, Tuesday, Wednesday practical classes to hand in by 4pm on Friday Week 5.
Thursday, Friday practical classes to hand in by 4 pm on Monday of Week 6.
Notebooks to be handed in on Monday of Week 3 (fieldtrip 1) and on Monday of Week 7 (fieldtrip 2, note this is one week after the trip).

Pre-requisite courses
N/A

Timetable

Semester:	Semester 1		
Lectures:	Monday	10:00 – 10:50	Appleton Tower LT 2
	Wednesday	10:00 – 10:50	G.07 Meadows Lecture Theatre, Doorway 4 (Medical School, Teviot)
	Friday	10:00 – 10:50	G.07 Meadows Lecture Theatre, Doorway 4 (Medical School, Teviot)
Practical classes:	Mon, Wed, Thurs, Fri	14:00 – 17:00	JCMB, Lab 6307
	Tues	09:00 – 12:00	JCMB, Lab 6307

(choose one of the five available slots)

Syllabus

Week 1.

L1 – Course Introduction. Earth in space and its Solar System context. Meteorites, volcanoes and the materials and composition of the Earth (De Hoog)
L2 - Earth through time: an introduction to the evolution of the Earth, geological time and the evidence for a 4550 million year old planet (De Hoog)
L3 - Earth Structure. An introduction to the lithosphere and asthenosphere, heat flow, the evidence for plate tectonics, and continental versus oceanic plates (Tait)

IT exercise 1: Web based Virtual Fieldtrip – accessed via Learn.
Practical 1: Assay of the Earth – Earth materials and Composition

Week 2.

L4 – Constructive plate margins. Plate boundaries, sea floor spreading, oceanic crust and magnetic anomalies (Tait)
L5 – Destructive plate margins: Subduction zones, continental collision and orogenesis (Tait)
L6 – Plate Motion and sedimentary processes (Tait)

Practical 2: The nature of the lithosphere and asthenosphere

September 30th <u>OR</u> October 1st. FIELD TRIP 1: PEASE BAY & SICCAR POINT.
***ATTENDANCE IS COMPULSORY.* Meet at Appleton Tower, ready to depart at 09:00.**

Week 3.

L7 – Isostasy and tectonic driving forces (Tait)
L8 – Continental rifting and sedimentation (Tait)
L9 – Introduction to geophysics, seismology and the structure of the Earth. Importance of geophysics, and investigation of the structure of the deep earth through seismology (Main)

Practical 3: Aspects of the motions of lithospheric plates

Week 4.

L10 - Earthquakes and seismotectonics. Different types of waves which travel through the Earth, and examine how seismology can be used to locate, measure and understand earthquakes (Main)
L11 - Refraction and reflection seismology. Differences between refraction and reflection seismology and how each technique allows us to comprehend the subsurface. Using active seismology to assess near surface solid earth structures (Main)
L12- Magnetism. Earth's magnetic field, geophysical techniques which use magnetic properties of the solid Earth to understand geological processes (plate tectonics, sea-floor spreading etc) (Main)

Practical 4: Be a Seismologist

Week 5.

L13 – Gravity measurements, how certain corrections needs to be applied to measurements to yield useful results, and what the results mean to understanding the subsurface (Main)
L14 – Magmas and igneous rocks; why volcanoes form; igneous intrusions (Fitton)
L15 – Volcanoes and volcanic hazards (Fitton)

Practical 5: Introduction to a microscope- optical mineralogy.
IT exercise2: Introduction to Holyrood Park – Learn exercise to be completed before field trip.

Sat 21st October <u>OR</u> Sun 22nd October. FIELD TRIP 2: Holyrood Park / Salisbury Crags / Arthur's Seat
***ATTENDANCE IS COMPULSORY.* Meet at 09:00 sharp at the grassy parkland area near the roundabout just inside from the St Leonards / Pollock Halls entrance to Holyrood Park. Field trip ends at approximately 12:30 pm.**

Week 6.

L16 – Introduction to rock-forming minerals (Fitton)
L17 – Basic crystallography (Fitton)
L18 – Composition and texture of igneous rocks; mineralogy and classification (Fitton)

Tutorial: Maps practical exercise

Week 7.

L19 – Magma evolution and fractional crystallisation (Fitton)
L20 – Supervolcanoes, hot-spots and large igneous provinces (Fitton)
L21 – Non-silicate minerals; economic mineral deposits (Fitton)

Practical 7. Salisbury Crags exercise; Salisbury Crags dolerite under the microscope; Top-ten silicate minerals.

Week 8.

L22 – Deformation of rocks: Stress, strain and deformation markers. Brittle and ductile behaviour and their manifestations – faults, shear zones and folds. Folding and thrusting in mountain belts young and old (De Hoog)
L23 – Metamorphism: The process of metamorphism. Change in mineralogy and texture to yield new rocks from old. Recrystallisation, reaction, equilibrium. The main metamorphic rock types in brief, arranged by texture and structure (De Hoog)
L24 – Metamorphic rocks and minerals: The key metamorphic minerals in rocks of shale-like composition. Factors of metamorphism: Pressure (P), temperature (T), fluids and strain. Timescale as a key parameter (De Hoog)

Practical 8: Igneous rocks in hand specimen and under the microscope; fractional crystallisation exercise; non-silicate minerals in hand specimen.

Week 9.

L25 – Contact Metamorphism - aureoles, thermal gradients and mineral zones in pelites. Isograds and index minerals. The Ballachulish example. (De Hoog)
L26 – Regional metamorphism – its scale and importance. Barrows zones, mineral isograds and index minerals; relations to P-T diagrams and mineral stabilities (De Hoog)
L27 – Geological resources. Types of resource : Energy, fossil and renewable; Minerals and geological processes; Environmental Services, air and water; Impact on human welfare through history (Haszeldine)

Practical 9: Deformation in the Earth.

Week 10.

L28 – Fossil energy, natural processes of genesis, maturation and concentration. Unconventional hydrocarbons. Extraction methods and impacts of use, such as air quality, radiation, climate change (Haszeldine)
L29 – Minerals: process styles of enrichment; sedimentary, industrial, metallic and Rare. Technology demands, trade, security of supply (Haszeldine)
L30 – Water resources and supplies in UK and globally, processing demands, population change. Ocean acidification and sea level change. Outlook for human control or adaptation, mining sea bed and asteroids (Haszeldine)

Practical 10: Metamorphic rocks and minerals; Contact and Regional Cases.

Week 11.

Revision week – Revision question and answer session with course lecturers. Date and time to be announced later.

Essential reading:

None, all necessary materials to pass (but not necessarily excel) the course exam are provided in the lectures.

Recommended reading:

- ‘Understanding Earth’ by JP Grotzinger & TH Jordan (*Freeman 7th edition, library has 5th edition which is also acceptable)*
- 'Looking into the Earth’ Mussett and Khan (*Cambridge University Press, 2000, in library*)

Note that material presented in lectures is self-contained. A good understanding and diligent revision will result in passing this part of the course, but not necessarily excelling. By 'recommended reading', we do not expect you to read every word, just to go in more depth into parts you are particularly interested in or less sure of, so you really understand the material, and can do really well in the exam.

Instead of Grotzinger you could also consult the following textbooks, which cover the same material in similar detail:

- 'Earth – Portrait of a Planet' by S Marshak (*WW Norton & Company 5th edition*, *library has 2012 4th edition which is fine)*
- 'Dynamic Earth – An introduction to Physical Geology' by EH Christiansen & WK Hamblin *Jones & Bartlett Learning 1st edition* (not in library, and not to be confused with the older book with the same name by Skinner and Porter)

http://www.docs.is.ed.ac.uk/docs/library/ResourceLists/Resource_Lists_and_the_Accesible_and_Inclusive_Learning_Policy.pdf

Contacts

Course Organiser	**Course Secretary**
CEES-JAN DE HOOG	NICOLA CLARK
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EASC08008 Introduction to Geophysics

Course Organiser:	WYN WILLIAMS	**Other Key Staff:**	IAIN MAIN, DAVID STEVENSON
Course Secretary:	NICOLA CLARK	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description

A comprehensive introduction to the physical study of the Earth, concentrating on descriptive and interpretative aspects of both pure and applied geophysics, including discussion of earthquakes and seismology, gravity, geomagnetism, the thermal state of the Earth and plate tectonics.

Further Course Information

https://path.is.ed.ac.uk/courses/EASC08008_SV1_SEM2
http://www.drps.ed.ac.uk/17-18/dpt/cxeasc08017.htm

Learning Outcomes

By the end of the course, you should
Have a broad knowledge and understanding of how geophysics is used to build up a picture of the interior of the Earth and the processes which generate its structure and surface features.
Be aware of how the same techniques used on the earth can be employed to remotely sense other planets, as well as the Earth's oceans and atmosphere.
Understand the principles of the geophysical techniques by which this information is derived.
Gained practical experience and understanding of some geophysical survey techniques in the field and how observations can be interpreted.
Be able to write a scientific report and critically evaluate evidence-based solutions.

Assessment and Feedback information

https://www.ed.ac.uk/files/atoms/files/taughtassessmentregulations.pdf
All details related to extensions procedures and late penalties can be found in the School of GeoSciences General Information Handbook 2017-18:
https://www.ed.ac.uk/files/atoms/files/general_information_handbook_0.pdf

Opportunities for feedback

Feedback will be given via written comments on class on class assessments and through in-class discussions. The course will also be supported by an on-line adaptive learning environment, where students can go through the course material at their own pace supported by formative online testing.

Assessment details

Written Exam: 70%, Course Work: 30 %, Practical Exam: 0%.

To pass you need to obtain an average of 40% or greater for the course - you *do not need* to pass both components. There is no resit component for the practical classes, but the resit exam may ask questions related to the practical classes.

The course work consists of 3 written reports based on the work completed in the practical classes. The first report (Pentland Fault Gravity Interpretation) is worth 6% of the course mark and the remaining two are 12% each.

Assessment deadlines

The practical classes will be split in to 2 or 4 groups depending on the nature of the practical. The assessment deadlines will 12 noon , two weeks following the date of your practical.

Week	Title	Assessment Due
16 or 18 Jan	No practical classes	
23 or 25 Jan	Pentland Fault Gravity Interpretation (groups a & b)	6 or 8 Feb
30 Jan or 1 Feb	Pentland Fault Gravity Interpretation (groups c & d)	13 or 15 Feb
6 or 8 Feb	Seismic Field Work (groups a & b)	Not Assessed
13 or 15 Feb	Seismic Field Work (groups c & d)	Not Assessed
27 Feb or 1 Mar	Seismic Data Interpretation	13 or 15 March
6 or 8 Mar	Magnetic/ Resistivity Field Work (groups a & b)	Not Assessed
13 or 15 Mar	Magnetic/ Resistivity Field Work (groups c & d)	Not Assessed
20 or 22 Mar	Resistivity Data Interpretation	3 or 5 Apr

Pre-requisite courses
NONE. Some high school science and mathematics is assumed.

Timetable
Semester: Semester 2
Lectures: 10.00 – 10.50
Monday – S1, 7 George Square, Central Area
Wednesday – Basement Theatre, Adam House
Friday – LT2, 7 Bristo Square, Central Area
Practical class: Tuesday or Thursday, 14.00- 17.00 (see schedule above)
Tutorial:

Syllabus
L1 Introduction to the course and the methodology of science. (Wyn Williams)
PART 1 (David Stevenson)
L2 Earth’s gravity, mass and density.
L3 Variation of gravity with latitude.
L4 Variation of gravity with altitude.
L5 Interpreting gravity anomalies.
L6 Isostasy.
L7 Gravity measurements and applications.
L8 Atmospheric geophysics.
PART 2 (Ian Main)
L9 Introduction to Seismology.
L10 Elementary elastic theory and seismic waves.
L11 Seismic refraction and crustal layering.
L13 Whole Earth Structure.
L14 Earthquake size.
L15 Earthquake focal mechanisms.
L16 Seismotectonics and seismic hazard.

PART 3 (Wyn Williams)
L17 Introduction to Geomagnetism and Geoelectricity.
L18 Earth's main magnetic field.
L19 The non-dipole field.
L20 Transient variation of the magnetic field.
L21 Magnetic survey methods.
L22 Electrical resistivity methods.
L23 Introduction to rock and palaeomagnetism.
L24 Geomagnetic polarity reversals.
L25 Continental drift and apparent polar wander paths.
L26 Geothermal Energy.
PART 4 (David Stevenson)
L27 Heat and temperature.
L28 Heat and time: daily, seasonal and glacial cycles.
L29 The Earth's Heat.
L30 Heat and time: thermal history of the Earth.

Recommended reading

Recommended Text to be bought for the Course:
Fundamentals of Geophysics
W. Lowrie; Cambridge University Press, September 2007
Alternative textbook for continuing Geophysics students:
Frank M. Stacey & Paul M. Davies, Physics of the Earth (2008)
(CUP, 4th edition)
Reference Texts for further reading:
An Introduction to Geophysical Exploration
P.K. Keary & M. Brooks; Blackwell, 1991 (Third Edition)
The Solid Earth: An introduction to Global Geophysics
C.M.R. Fowler; Cambridge University Press.
Looking into the Earth
Alan Mussett & Aftab Khan; Cambridge University Press.
Earthquakes
Bruce Bolt; Freeman Press 1999 (Fourth edition)
Introduction to Seismology, Earthquakes & Earth Structure
Seth Stein & Michel Wysession; Blackwell
Introduction to Seismology (suitable for continuing geophysicists)
Peter M. Shearer; Cambridge University Press, 1999
All textbooks are available in the reserve collection of the Noreen and Kenneth Murray Library, Kings Buildings Campus.

https://www.ed.ac.uk/files/atoms/files/accessible_and_inclusive_learning_policy.pdf

Contacts

Course Organiser
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Tel: 650 4909

Course Secretary
NICOLA CLARK
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EASC08016 Physics of the Earth

Course Organiser:	Mark Naylor	**Other Key Staff:**	Wyn Williams ; John McCloskey
Course Secretary:	Nicola Clark	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description

A comprehensive introduction to the physics of the Earth, concentrating on earthquake and controlled-source seismology, physical geodesy and the Earth's gravity field, and geomagnetism and geo-electricity. The course emphasises interpretation and understanding using the techniques of physics and mathematics.

Further Course Information

https://path.is.ed.ac.uk/courses/EASC08016_SV1_SEM2
http://www.drps.ed.ac.uk/17-18/dpt/cxeasc08016.htm

Learning Outcomes

At the end of this course, you should have a broad, comprehensive overview of the physical processes operating in the solid Earth and its core and a quantitative understanding of the principles of the geophysical techniques by which this information is derived. You will also have gained practical experience and understanding of geophysical exploration techniques and how observations can be interpreted. These practical sessions will give you experience of carrying out routine lines of enquiry into professional level problems. You will be able to critically evaluate evidence based solutions to these problems. The assessed scientific report and degree exams will give you practice conveying complex information to a range of audiences for a range of purposes which is a valuable transferable skill.

Opportunities for feedback

The tutorials are an opportunity to get feedback on exam relevant questions. You will get the most out of these by attempting the questions in advance. They are available on Learn.

In the first week there is a formative Practical, which will be marked and the results returned to you prior to the hand-in of the second assessment – which contributes to your mark. You will have the opportunity to get individual feedback on the first report in a meeting with the CO, Mark Naylor.

Further subject specific questions can be directed towards the relevant lecturers and/or the demonstrators.

Assessment details

Written Exam: 70%, Course Work: 30 %, Practical Exam: 0%.

The exam consists of a single 3hr written paper in Apr/May.
Past exam papers: **https://exampapers.ed.ac.uk/search/Physics+of+the+Earth**

The coursework consists of three reports based on 3 of the Practicals (see below), each contributing 10% to the overall mark. The reports should not exceed 1500 words.

If you want to attain the best marks – it is worth looking at the Common Marking scheme to understand how you will be assessed.

Assessment deadlines

There are three practical assessments that must be handed in during Semester 2 with a report describing the aims, background, method, results and conclusions from each practical exercise.

These assessments will be submitted electronically **except for the third assessment on 20th March which is to be submitted** in hard copy – please see details below and on the Learn submission page. The hardcopy assessment is to be submitted into the Teaching Office, Room 332 in the Grant Institute by 12noon on the deadline day. Any electronic or hardcopy assessment handed in without a satisfactory explanation after the due date will be subject to an automatic penalty, so if you are aware of a problem, please do let the Course Organiser and your Personal Tutor know before the hand-in date.

For information regarding the School of Geosciences policy for Special Circumstances please see:
http://www.ed.ac.uk/geosciences/teaching-organisation/staff/programme-studies-tutors/ugspec-circ

Practical Hand-In Deadlines:

P1 – Week 3, Tuesday 30 January 2018, 12noon (FORMATIVE) via Turnitin submission box on Learn

P2 – Week 6, Tuesday 27 February 2018, 12noon (ASSESSED) via Turnitin submission box on Learn

P3 – Week 9, Tuesday 20 March 2018, 12noon (ASSESSED) hard copy submission via Rm 332 Grant Institute

P4 – Week 13, Tuesday 17 April 2018, 12noon (ASSESSED) via Turnitin submission box on Learn

Assessment and Feedback information

http://www.ed.ac.uk/files/atoms/files/taughtassessmentregulations.pdf

All details related to extensions procedures and late penalties can be found in the
School of GeoSciences General Information Handbook 2017-18

Pre-requisite courses

Students MUST have passed: Mathematics for Physics 1 (PHYS08035) AND Mathematics for Physics 2 (PHYS08036) AND it is RECOMMENDED that students have passed Introduction to Geophysics (EASC08008)

Timetable

Semester:	Semester 2
Lectures:	Monday 12-1pm Classroom 6, Hudson Beare Building
	Friday 1-2pm Classroom 6, Hudson Beare Building
Practical class:	Tuesday 1-5pm Please check the timetable for weekly locations: https://tinyurl.com/y8apb6qh
Tutorial:	Wednesday 11-12pm LT40, Joseph Black Building

<u>Lectures – Mondays 12:10-13:00 AND Fridays 13:10-14:00</u>

Part 1: Seismology: vibrations, waves and earthquakes (Mark Naylor)

L1. Basic elasticity: stress & strain tensors, elastic moduli
L2. Elastic waves: derivation of the 1-D wave equation for plane P and S waves
L3. Seismic refraction: two-layer problem for flat and dipping layers
L4. Seismic refraction: linear velocity change, Ray Tracing, Travel Time Curves
L5. Seismic recording: basic principles of the mechanical seismometer
L6. Seismic reflection: calculation of reflection coefficient at normal incidence
L7. The convolution model for a seismogram
L8. Seismic attenuation: geometric spreading, anelastic attenuation, and scattering

Part 2: Electricity and Magnetism (Wyn Williams)

L9. Fundamental units in magnetism and electricity
L10. The geomagnetic field; The magnetic field of a dipole; Multipole and spherical harmonic representation of the geomagnetic field
L11. Introduction to hydromagnetic dynamos
L12. Geomagnetic instrumentation and design
L13. Solar-terrestrial interactions of the geomagnetic field
L14. Telluric currents and the conductivity structure of the Earth.
L15. EM methods of prospecting
L16. Magnetic properties of rocks

Part 3: Gravity (John McCloskey)

L17. Gravity and the gravitational constant, G
L18. The geo-potential
L19. Theory of the reference Earth model
L20. Earth's gravity field
L21. Interpretation: theory
L22 Interpretation: modelling

<u>Tutorials – Wednesdays 11:10-12:00</u>

Seismology: Weeks 2,3,4,5
Electricity and Magnetism: Weeks 6,8
Gravity: Weeks 10,11

<u>Practical Sessions – Tuesdays 13:10-17:00</u>

P1. Seismograms: first motions and earthquake focal mechanisms (Wk1: Formative)

Practical Class: Week 1: Tuesday 13:10-17:00 (Formative)
Handin: Week 3: Tuesday 30 January 12noon

P2. Seismograms: seismic phases, travel-time curves, and earthquake location (Wk4: Assessed)

Week 4: Tuesday 13:10-17:00 (Assessed)
Handin: Week 6: Tuesday 27 February 12noon

P3. EM survey interpretation (Wk7: Assessed)

Week 7: Tuesday 13:10-17:00 (Assessed)
Handin: Week 9: Tuesday 20 March 12noon

P4. Interpreting gravity and magnetic anomalies (Wk11: Assessed)

Week 11: Tuesday 13:10-17:00 (Assessed)
Handin: Week 13: Tuesday 3rd April 12noon

Recommended reading

Recommended purchase:

Lowrie, W., 1997. Fundamentals of Geophysics, Cambridge Univ. Press.

Additional texts where funding allows:

Kearey, P.K., 1991. An introduction to Geophysical Exploration, Blackwell.

Stein S. and M. Wysession, 2003. Introduction to seismology, earthquakes and Earth structure, Blackwell. (Recommended purchase for those continuing to honours in geophysical subjects).

Shearer, P. 1999. Introduction to Seismology, Cambridge University Press.

Reference texts:

Fowler, C.M.R., 2005. The Solid earth: an introduction to Global Geophysics, Cambridge University Press.

Mussett, A. and A. Khan, 2000. Looking into the Earth, Cambridge University Press.

All of these are available in the reserve collection of the KB library.

https://www.ed.ac.uk/files/atoms/files/accessible_and_inclusive_learning_policy.pdf

Contacts

Course Organiser	Course Secretary
MARK NAYLOR	Nicola Clark
Email: mark.naylor@ed.ac.uk	Email: nicola.clark@ed.ac.uk
Tel: 0131 6504918	Tel: 0131 650 4842

EASC08017 Introduction to the Geological Record

Course Organiser:	Kate Saunders	**Other Key Staff:**	Rachel Wood, Stuart Gilfillan, Mark Wilkinson, Mikael Attal, Andy Hein, Mark Naylor, Alex Thomas.
Course Secretary:	Nicola Clark	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description

This course is ONLY available to students taking:
GEOLOGY BSc AND MEarthSci
GEOLOGY AND PHYSICAL GEOGRAPHY BSc & MEarthSci
ENVIRONMENTAL GEOSCIENCE BSc
GEOPHYSICS & GEOLOGY BSc
PRIMARY EDUCATION WITH EARTH SCIENCES MA (Hons)

The course will teach 3D mapping and cross-section skills, as well as 4D-thinking abilities - areas highlighted by both a recent external Teaching Quality Assurance (TQA) and Industry as being a vital skill. These will be taught via integration of maps with rock identification in a way not previously achieved. The course will also introduce the application of online digital databases (BGS and USGS maps; Digital Elevation Models; radar interferometry; remote sensing; imagery) in solving global geological problems. The course will logically follow the core course Earth Dynamics (Semester 1), and prepare students for mapping fieldwork at the beginning of year 2.

Compulsory fieldtrip to the Lake District on EITHER 9-15 April OR 28 May to 3 June '18. Students will be allocated onto one of these trips in Semester 1. Antipated cost of the trip is around £150.

Further Course Information

https://path.is.ed.ac.uk/courses/EASC08017_SV1_SEM2
http://www.drps.ed.ac.uk/17-18/dpt/cxeasc08017.htm

Learning Outcomes

At the end of the semester, student should have gained:

- knowledge of applied techniques that are necessary to understand and interpret the Earth's surface as expressed in maps and other 2/3D data.
- knowledge of the fundamentals of the analysis and critical interpretation of geological maps.
- ability to evaluate geological maps and the history they record and apply field mapping skills in diverse geological settings.
- knowledge of the modern remote sensing techniques that can be used to complement the geological information recorded at the surface of the Earth.
- basic understanding of how the combination of geological surface data and remotely sensed data can be used to reconstruct the subsurface and assess hazard (earthquakes, volcanoes, landslides).

Opportunities for feedback

Students will have the opportunity to receive feedback in the following instances:

- Personal 1-to-1 feedback during the practicals, as students progress on the exercises (once a week); feedback will be provided by demonstrators and teaching staff.
- Feedback on exam map practice during Innovative Learning Week: students will complete a cross-section on previous year’s exam map under the guidance of teaching staff and demonstrators. The cross-section will then be marked and feedback provided.
- Personal 1-to-1 feedback during the Lake District field trip as students progress on producing the material that will ultimately be assessed (notebook, map, cross-sections); feedback will be provided by demonstrators and teaching staff.
-

Examples of feedback can be found here:
http://www.ed.ac.uk/schools-departments/geosciences/teaching-organisation/staff/feedback-and-marking

Assessment details
Written Exam: 40%, Course Work: 60 %, Practical Exam: 0%.

Exam: students will annotate a geological map and produce a cross-section and a geological history in three hours (50 % map + cross-section, 50 % geological history).

Course work:

- Two practicals will be assessed, representing 10 % of the final mark each (20% total); students will hand in the material they produced at the end of the practical.
- Three multiple choice quizzes. Two to be held randomly in any of the sixteen lectures given in this course in weeks one to nine. These quizzes will only be accessible during the lecture period that the quiz is given in, unless special circumstances are submitted. The third will be completed during the students' own time between weeks one and eight. Each quiz is worth 3.333% and together 10% of the total course mark.
- 10% for Lake District notebook
- 20% for map and cross section completed during the Lake District field trip.

Students are required to attend and participate in all aspects of the programme of study, including teaching sessions, assessments and examinations. Therefore, may we please take this opportunity to remind you that all course work assignments fall under the same rules as examinations. If you miss an assessed piece of coursework for any reason, you will need to submit special circumstances via your PT and/or Student Support Coordinator. Therefore please do check the timetable carefully. Assessed practical will not be rearranged on a bespoke basis for individual students, unless special circumstances are submitted and approved. The University expect all student to be autonomous learners and active participants in their own education.

To pass the course, students need to obtain at least 40% FOR BOTH COURSEWORK AND EXAM. If they do not achieve this at the first attempt, the following will apply:

- If they have failed the exam component but passed the coursework component, they will resit the exam in August.
- If they have failed the coursework component but passed the exam component, their exam mark will be carried forward and they will reattempt to pass the coursework next year (they will sign up for the course as "coursework only").
- If they have failed both components, they will resit the exam in August and will reattempt to pass the coursework next year.

Assessment deadlines
- Thursday 15th February 2018 (15 minutes after end of assessed practical #1): cross section (to hand in to secretary Nicola Clark in room 332 Grant Institute).
- Thursday 22nd March 2018 (15 minutes after end of assessed practical #2): questionnaire based on geological map (to hand in to secretary Nicola Clark in room 332 Grant Institute).
- Three multiple choice quizzes to be completed between weeks one and eight. Two to be held randomly in any of the sixteen lectures given in this course in weeks one to nine. These quizzes will only be accessible during the lecture period that the quiz is given in, unless special circumstances are submitted. The third will be completed during the students' own time between weeks one and eight.
- Last day of one-week field trip to the Lake District (15th April OR 3rd June 2018), 8:00 am for maps and cross-sections; on return to the Grant Institute for field notebook.

Assessment and Feedback information
http://www.ed.ac.uk/files/atoms/files/taughtassessmentregulations.pdf

All details related to extensions procedures and late penalties can be found in the
School of GeoSciences General Information Handbook 2017-18

Pre-requisite courses
None
This course is ONLY available to students taking:
GEOLOGY BSc AND MEarthSci
GEOLOGY AND PHYSICAL GEOGRAPHY BSc & MEarthSci
ENVIRONMENTAL GEOSCIENCE BSc
GEOPHYSICS & GEOLOGY BSc

Timetable

Semester:	Semester 2	
Lectures:	Tuesday 9-10 am	Teviot LT Doorway 5, Medical School
	Wednesday 9-10am	F.21, 7 George Square
Practical class:	Thursday 9-11am	JCMB Lab 6231 wks 1-10
Computer Workshop:	Thursday 9-11am	Room 2.02 Drummond Street wk 7

Syllabus

Teaching Week		Content + lecturer: *Each Week is composed of 2 lecture slots and one 2 hour practical slot* ***(MA: Mikaël Attal; SG: Stuart Gilfillan; KS: Kate Saunders; MW: Mark Wilkinson; RW: Rachel Woods)***	Mark
1	Lectures	**1.** Introduction to the course; Introduction to maps (SG) **2.** Introduction to geological time (RW)	
	Practical	Field map navigation practical, plus 'orienteering' course (SG)	
2	Lectures	**3. Introduction to Stratigraphy (Bio-;Litho-; Chemo- and Sequence stratigraphy (RW)** 4. **Introduction to unconformities and processes of formation (RW)**	
	Practical	Introduction to structural contours and map interpretation techniques; introductory maps (RW)	
3	Lectures	5. Clastic **Sedimentary rocks (RW)** 6. **Carbonates (RW)**	
	Practical	Sea-level curve exercise, link with geological history, hand specimen description (RW)	
4	Lectures	7. Introduction to Structural Geology **(SG)** 8. Introduction to hand specimen descriptions and intro to fieldtrip (SG)	
	Practical	Introductory structural map with hand specimen description (SG)	
5	Lectures	**9. Introduction to structure on maps (SG)** 10. **How to write a Geological History (SG)**	
	Practical	Structural map exercise (SG) Assessment = cross-section to be handed in at the end of the practical	10
		INNOVATIVE LEARNING WEEK – exam practice using a previous year's map	
6	Lectures	11. **Introduction** to igneous geology in the field (KS) 12. **Introduction to metamorphic geology in the field (KS)**	
	Practical	Igneous and Metamorphic field relations on geological maps (KS)	
7	Lectures	13. & 14.Remote Sensing (MA)	

	Practical	Lake District DEM exercise – Computing Rm, Drummond Street (MA)	
8	Lectures	15. Introduction to Lake District Geology **(MW)** 16. Field excursion logistics and how to take notes in a notebook (*MW*). It is essential that you attend this lecture – attendance will be monitored.	
	Practical	Case study Geological Map: Lake District **(MW and SG)**	
9	Case Study Geological Map no. 2 (SG)		
	Assessment = questionnaire to be handed in at the end of the practical.		10
	Multiple-choice quizzes	Three quizzes each worth 3.333%. Two to be held randomly in any of the sixteen lectures given in this course in weeks one to nine. The third to be completed in students own time between weeks one and eight.	10
	EXAM	MAP PROBLEM	40
	LAKE DISTRICT	Notebooks Map and Cross Section	10 20

Recommended reading

Essential Reading

Bennison, G.M. (2011) *An introduction to geological structures and maps*. Hodder Education.

Recommended

Coe, A.L. (2010) *Geological field techniques*. The Open University; Wiley-Blackwell.

Stow, D.A.V. (2005) *Sedimentary rocks in the field: a colour guide*. Manson.

The Geological Society of London Handbook Series

McClay, K.R. (1991) *The mapping of geological structures*. J. Wiley.

Jerram, D. (2011) *The field description of igneous rocks*. Wiley-Blackwell.

Fry, N. (1984) *The field description of metamorphic rocks*. Open University Press.

http://www.docs.is.ed.ac.uk/docs/library/ResourceLists/Resource_Lists_and_the_Accessible_and_Inclusive_Learning_Policy.pdf

Contacts:

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EASC08021 Geomaterials

Course Organiser:	TETSUYA KOMABAYASHI	**Other Key Staff:**	Kate Saunders, Geoffrey Bromiley
Course Secretary:	NICOLA CLARK	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description

In this course we explore the fundamental nature of the material which constitutes the Earth and other planets. In the Mineral Science section we consider how atoms are arranged in crystalline materials and how this ultimately governs the nature of geomaterials. Interaction of crystalline materials with light, X-rays and electrons are used to introduce the theoretical and practical basis behind the polarising microscope, X-ray diffraction and electron microscope/microprobe. In Composition of the Earth we review the main groups of Earth Materials, considering (1) how structure, chemistry, physical properties, and occurrence are interrelated, (2) how earth materials are used in modern research as information sources to reveal the nature of Earth processes, and (3) introduce theoretical aspects of modern Earth Materials research (e.g. phase stability and transitions). In the final section Chemical Equilibria we consider how the stability and occurrence of geomaterials can be predicted and determined numerically using thermodynamics, and consider factors governing the rates of Earth processes at variable depths.

Further Course Information

https://path.is.ed.ac.uk/courses/EASC08021_SV1_SEM1
http://www.drps.ed.ac.uk/17-18/dpt/cxeasc08021.htm

Learning Outcomes

1. To gain a broad knowledge and understanding of the constituent materials which make up the solid Earth, and how the study of minerals can be used to understand the processes which have shaped the Earth throughout geological time.
2. To identify, describe and interpret geomaterials from an atomic level to a hand specimen scale, and to be familiar with the foundations and application of modern methods used to study geomaterials: diffraction, optical mineralogy, electron microbeam analysis
3. Have a broad understanding of the most important groups of minerals which constitute the Earth, and develop an understanding of the relations between different groups of materials, their occurrence, formation and stability, and how this information can be used to understand processes occurring on the Earth.
4. To understand how stability of earth materials can be predicted and determined using thermodynamics, and how the rates of atomic processes govern Earth processes.

Students are actively encouraged to discuss academic problems with fellow students and to work in collaboration: invaluable transferable skills. This course will develop student's theoretical understanding of the study of Earth materials, observational and analytical skills, and numerical skills through lectures and lab-based practicals.

Opportunities for feedback

Coursework will be returned to students within a maximum of 2 weeks of the submission deadline, with individual feedback from instructors and with recommendations as to how students can improve their grades.
General class feedback is also given in practical classes or on LEARN course site.
In some lectures, instant feedback is provided to large classes using the TOPHAT system.
Information will be given to students prior to setting assessed work.

Assessment details

Assessments are based on, written Exam: 50%, Course Work: 50 %, Practical Exam: 0%.
Written exam is in the end of the semester and covers all the materials from the course (Mineral Science (20%), Composition of the Earth (40%), and Chemical Equilibria (40%)).
Course works are two assessed practicals (Composition of the Earth (40%), Chemical Equilibria (40%)) and group poster presentation (20%)).

To pass the course students must achieve an overall mark of 40% or more. Students must also achieve a minimum of 40% in both the Degree examination and in the Classwork component to attain a pass overall, whatever their final aggregate mark.

A1 (90-100) = Excellent; outstanding (1^{st}). **A2** (89-90) = Excellent – a high 1^{st}.
A3 (70-79) = Excellent; (1^{st}). **B** (60-69) = Very good; (2.1). **C** (50-59) = Good; (2.2)
D (40-49) = Pass; (3^{rd}). **E** (30-39) = Marginal fail. **F** (20-29) = Clear fail.
G (10-19) = Bad fail. **H** (0-9) = Very bad fail.

Assessment deadlines

Assessed work completed in class time (Composition of the Earth) will be collected in, at the time, by the member of staff conducting the exercise. If you are present for the exercise it is your responsibility to place your completed write-up in the receptacle provided or to see that your test paper is presented to whoever is collecting the material. Assessed work done in your own time (Chemical Equilibria) will be submitted electronically on LEARN .

The deadline for each assessment is: end of the semester (written exam); Thursday/Friday of week 4 (Composition of the Earth); Thursday/Friday of week 6 (Group poster presentation); 12:00am on Monday of week 11 (Chemical Equilibria).

Assessment and Feedback information
http://www.ed.ac.uk/files/atoms/files/taughtassessmentregulations.pdf

All details related to extensions procedures and late penalties can be found in the:

School of GeoSciences General Information Handbook 2017-18

Pre-requisite courses
Students MUST have passed: Earth Dynamics (EASC08001).

Timetable

Semester:	Semester 1
Lectures:	Monday 2-3 pm Grant MLT 201
	Thursday 12-1 pm Grant MLT 201
Practicals:	EITHER Mon 3-5pm OR Tues 11-1pm and Thurs OR Fri 2-5pm
	Rm 6231, JCMB
Computer Workshop:	Mon 3-5pm, Tues 11-1pm, Thurs & Fri 2-5pm Wk 9

Recommended reading
Essential
Nesse, WD (2011) *Introduction to Mineralogy*. Oxford.
Anderson GM (2009) Thermodynamics of Natural Systems. Cambridge University Press.

Recommended
Klein C (2007) *Mineral Science*. Wiley.
Klein C and Philpotts A (2016) *Earth Materials. Cambridge University Press.*
Deer, Howie & Zussmann (1992) An *Introduction to the Rock Forming Minerals*. Prentice Hall
Best MG (2002) Igneous and Metamorphic Petrology. Blackwell Science.
Gill R (2008) Chemical Fundamentals of Geology. Springer.
Ganguly, J. (2008) Thermodynamics in Earth and Planetary Sciences. Springer.
Cemic, L. Thermodynamics in Mineral Sciences
McKenzie & Guilford, *Atlas of Rock-forming Minerals*. Routledge
McKenzie & Adams, *A Colour Atlas of Rocks and Minerals in Thin Section*. Manson

Further reading

Putnis, A. *Introduction to Mineral Sciences*. Cambridge.
LangClark D (1997). Aqueous Environmental Geochemistry. Prentice Hall.

http://www.docs.sasg.ed.ac.uk/AcademicServices/Policies/Accessible_and_Inclusive_Learning_Policy.pdf

Contacts

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Course Secretary
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METE08001 Meteorology: Atmosphere and Environment

Course Organiser:	David Stevenson	**Other Key Staff:**	Ruth Doherty, Massimo Bollasina
Course Secretary:	Nicola Clark	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description
An introduction to the physical processes occurring in the Earth's atmosphere. Interpretation of weather maps and satellite images, cloud types and formation, atmospheric structure, thermodynamic processes, rain formation, solar and terrestrial radiation, energy balance at the surface, cumulus and cumulonimbus convection, air pollution.

Learning Outcomes
By the end of the course you will have a broad knowledge of the main areas of Meteorology and you will be able to:
- Use and evaluate numerical and graphical data:
- Interpret weather maps in terms of local weather
- Plot and interpret vertical temperature and moisture soundings
- Observe, code and plot weather elements in standard format
- Recognise cloud types and be able to describe their formation mechanisms
- Describe the basic processes occurring in the atmospheric boundary layer
- Describe and explain the structure, physics and dynamics of thunderstorms, tornadoes and hail formation
- Describe the layers of the atmosphere from the surface to 100km+
- Explain the basic physics of atmospheric processes, such as radiation at the surface, water in the atmosphere and its phase changes
- Carry out routine lines of enquiry into professional level problems
- Undertake critical analysis and synthesis of mainstream ideas as part of the coursework assessment.

Further course information
https://path.is.ed.ac.uk/courses/METE08001_SV1_SEM1
http://www.drps.ed.ac.uk/17-18/dpt/cxmete08001.htm

Opportunities for feedback
Students receive brief initial feedback on their lab books after three labs, and written feedback on their mid-S1 assignment. Labs are informal and allow students to ask questions about what they are doing of demonstrators and staff. Clickers are used in some lectures to gauge understanding of the student cohort (individual student responses are not monitored). A discussion forum is on Learn. There is the opportunity to ask questions during or after lectures. After the exam (usually early the following semester), students can read marked exam scripts and question the markers on any comments or the marks achieved.

Assessment details
Written Exam: 70%, Course Work: 30 %, Practical Exam: 0%.

Both coursework and the exam must be passed (i.e. a mark of 40% or above). There is no option to resit coursework in the summer, unless special circumstances are a factor.
Coursework is made up of three items, each worth 10%: (i) the mid-S1 assessment - this typically involves analysis and interpretation of some meteorological data - e.g., calculations, plotting graphs, writing something; (ii) the completed lab-book - with entries for each of the eight labs; (iii) the observations test.
The 2 hour exam is split into two sections: (A) 20 multiple choice questions, worth 40%; (B) 4 longer answer questions, choosing one question from each of four groups of two questions.

Assessment deadlines
Assignment: 12 noon Friday 20 October
Observations Test: Week 10 lab
Lab book: 12 noon Friday 24 November

Assessment and Feedback information

http://www.ed.ac.uk/files/atoms/files/taughtassessmentregulations.pdf All details related to extensions procedures and late penalties can be found in the School of GeoSciences General Information Handbook 2017-18

Pre-requisite courses: None, but it is recommended that students have some background in maths/physics (e.g., A-level/Scottish Higher)

Timetable				
Semester:	Semester 1			
Lectures:	M W F 10.00-10.50			
Practical class:	Choose one of: M 14.10-15:30, T 10.00-11.30, Th 14.10-15.30			

https://path.is.ed.ac.uk/courses/METE08001_SV1_SEM1

Syllabus

Week 1: Overview, introduction to weather maps and satellite imagery
Weeks 2-3: Atmospheric structure, meteorological observations, interpreting charts
Week 4: Air masses and weather fronts
Week 5: Clouds and precipitation
Weeks 6-7: Vertical profiles through the atmosphere: physics, stability, thunderstorms
Weeks 8-9: Atmospheric radiation, surface energy balance, rainbows
Week 10: Air pollution, course review

Recommended reading

Introducing Meteorology: A Guide to Weather, J. Shonk
Atmospheric Science: An Introductory Survey (2nd Ed), J.M. Wallace and P.V. Hobbs

Contacts

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Course Secretary
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METE08002 Meteorology: Weather and Climate

Course Organiser:	RUTH DOHERTY	**Other Key Staff:**	Hugh Pumphrey, Richard Essery
Course Secretary:	Nicola Clark	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description

An introduction to large-scale weather systems and climate processes. Radiation and climate, role of the oceans, greenhouse effect, atmospheric dynamics, global circulation, thunderstorms, hurricanes, mid-latitude weather systems, weather and climate forecasting.

Further Course Information

https://path.is.ed.ac.uk/courses/METE08002_SV1_SEM2
http://www.drps.ed.ac.uk/17-18/dpt/cxmete08002.htm

Learning Outcomes

By the end of the course the student will:
- Have a broad knowledge of the main areas of large-scale Meteorology
- Be able to describe:
    - The components of the climate system and understand how these interact with each other
    - The global radiation balance and the physics underlying the greenhouse effect
- Display a basic understanding of the dynamics of the atmosphere and its interaction with the underlying ocean and land
- Be able to apply knowledge of the forces acting on the atmosphere to quantitatively interpret the atmospheric circulation
- The atmospheric structure of tropical cyclones
- The structure and air motions in mid-latitude cyclones, anticyclones and other types of low pressure systems
- Be able to explain modern approaches to weather and climate forecasting
- Be aware of a range of standard applications used in meteorology to process and obtain data
- Be able to demonstrate their understanding through degree exam and course work.

Opportunities for feedback

Two lecture slots will be dedicated to feedback for the two course assignments. The first lecture will provide in depth general feedback to the students in advance of the second assignment so that feedback given here is useful for the second course assignment. A general feedback session on the second assignment will also be given, and this will also be useful for exam preparation. All students will be invited to an examination feedback session following release of course results. Clickers will be used in lectures to provide instant feedback to large classes. Exam marking includes comments to students. Examples of feedback can be found here: http://www.ed.ac.uk/schools-departments/geosciences/teaching-organisation/staff/feedback-and-marking

Assessment details

Written Exam: 70%, Course Work: 30 %, Practical Exam: 0%.
The course work assignment will consist of two written lab reports (15% each). The labs run from weeks 2-10. Students will be asked to provide a write-up of two of the labs and guidance on report writing will be given in class as well as in the course handbook. For this reason lab attendance is compulsory.

Assessment deadlines

There will be two submission deadlines in the semester. These will be the Mondays of week 5 (radiation) and week 9 (weather balloon). The deadlines are therefore **12noon on Monday 12th February** and **12noon on Monday 19th March 2018**. Assessments must be submitted electronically on Learn via the Turnitin dropbox; hard copies may also be submitted if this makes graphics re-production easier to the course secretary Nicola Clark in room 332, Grant Institute.

Assessment and Feedback information
https://www.ed.ac.uk/files/atoms/files/taughtassessmentregulations.pdf
All details related to extensions procedures and late penalties can be found in the School of Geosciences Undergraduate General Information Handbook 2017-2018.

Pre-requisite courses
It is RECOMMENDED that students have passed Earth Modelling and Prediction (GESC08002) OR Meteorology: Atmosphere and Environment (METE08001)

Timetable
Semester: Semester 2

Lectures	Monday	10-11am	Classroom 4, Hudson Beare Building
	Wednesday	10-11am	Wk 1 Classroom 4, Hudson Beare Building
			Wks 2 -11 LT1, Sanderson Building
	Friday	10-11am	Classroom 4, Hudson Beare Building
Labs	Monday	2-3.40pm	Meteorology Teaching Lab, JCMB Wks 2, 4, 6, 7, 9, 10
	Balloon Experiment	2.10-4pm	Meteorology Teaching Lab, JCMB Wk 7
	Tuesday	10-11.30am	Meteorology Teaching Lab, JCMB Wks 2, 4, 6, 7, 9 & 10
	Balloon Experiment	10-12pm	Meteorology Teaching Lab, JCMB Wk 7
	Thursday	2-3.40pm	Meteorology Teaching Lab, JCMB Wks 2, 4, 6, 7, 9 & 10
	Balloon Experiment	2.10-4pm	Meteorology Teaching Lab, JCMB Wk 7
Comp Workshop	Monday	2-3.40pm	KB Centre Computing Lab (20 seater) wk 4
	Tuesday	10-11.30am	KB Centre Computing Lab (20 seater) wk 4
	Thursday	2-4pm	KB Centre Computing Lab (20 seater) wk 4

https://browser.ted.is.ed.ac.uk/generate?courses[]=METE08002_SV1_SEM2&show-close=1&no-timeframe-change=1&period=SEM2

Syllabus
Example Syllabus

Week 1
Introduction, course content, weather maps;
Satellite; Images Components of the climate system

Week 2
Basics of radiation: solar and terrestrial, properties of a perfect radiator; Equilibrium temperature of Earth; The greenhouse effect

Week 3
Feedbacks in the climate system; The role of the oceans in the climate system; Climate forcings

Week 4
Climate variability and change; General Circulation; Pressure and Forces

Week 5
Coriolis forces; Geostrophic balance; Inertial oscillations and Cyclostrophic motion

Week 6

Gradient wind, boundary layer friction; The Thermal wind; Feedback Session on Radiation Ocean Lab

Week 7
Convergence and divergence; Vorticity; Tropical cyclones, locations, structure

Week 8
Tropical cyclones: formation, and growth mechanisms; Mid-latitude cyclones: Warm, Cold and occluded fronts; Mid-latitude cyclones: Life cycle

Week 9
Mid-latitude cyclones: Upper level flow; Other types of low pressure systems; Anticyclones and Weather Forecasting 1

Week 10
Weather Forecasting 2; Weather and climate prediction; Feedback Session on Balloon experiment

Recommended reading

The basic text for the course is 'Meteorology Today' (10th edition) by C. Donald Ahrens, Brooks/Cole Publishing, however the latest edition has become too expensive to buy. Some copies from members of previous year's class may be available for purchase. Earlier editions of this book (especially the 8th and 9th editions) are quite satisfactory. For the less mathematical parts of the course: Introducing Meteorology: A Guide to Weather (Jon Shonk) £8.99 is a good read. 'Atmospheric Science' (2nd edition) by Wallace and Hobbs £47 (from Blackwells) is also useful and is more mathematical than Ahrens.

https://www.ed.ac.uk/files/atoms/files/accessible_and_inclusive_learning_policy.pdf

Contacts

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PHYS08016 Physics 1A: Foundations

Course Organiser:	Ross Galloway	**Other Key Staff:**	
Course Secretary:	Rhona Johnson	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description
This is an introductory-level course, covering the classical physics of kinematics, dynamics, oscillations, forces and fields, and touching on aspects of contemporary physics, including relativity and chaos. The course is designed for those with qualifications in physics and mathematics at SCE-H level or equivalent. It serves both as a preparation for further study in physics-based degree courses, and as a stand-alone course for students of other disciplines, including mathematics, chemistry, computer science and engineering. The course is supported by an IT resource base of multimedia teaching material. The course is appropriately combined with Physics 1B (PHY-1-B).

Learning Outcomes
1)understand and employ the concepts of order of magnitude and significant figures in solving numerical problems
2)be able to use and manipulate vectors to describe physical quantities, such as motion in one or two dimensions, torque etc.
3)know and be able to apply the equations describing motion at constant acceleration and motion in a circle at constant speed
4)state the Galilean description of relative motion and be aware of its limitations
5)understand the roles played by force, mass and inertial reference frames in the laws of motion
6)be familiar with a wide variety of the forces encountered in nature
7)apply Newton's Laws to analyse the behaviour of systems experiencing such forces
8)qualitatively understand the ficticious forces experienced in non-inertial reference frames
9)state the definitions of work, kinetic energy and potential energy
10)explain why a potential energy can only be defined for a conservative force
11)use the principle of conservation of energy to solve simple problems
12)understand the concept of the centre of mass, its velocity and momentum for a system of particles
13)state conditions under which linear and angular momentum is conserved
14)analyse different types of collisions using appropriate conservation laws
15)know the analogies between variables describing linear and rotational motion
16)understand the concepts of angular velocity and torque
17)construct the simple harmonic equation of motion for a range of systems and determine the associated frequency
18)be familiar with the mathematical description of sinusoidal waveforms and the variety of phenomena occurring when different waveforms are combined

Opportunities for feedback
See specific Course Handbook for details

Assessment details
Written Exam: 70%, Course Work: 30 %, Practical Exam: 0%.
See specific Course Handbook for details

Assessment deadlines
See specific Course Handbook for details

Pre-requisite courses
SCE Higher Grade Physics and Mathematics (at Grade A) or equivalent.

Timetable

Semester:	Semester 1
Lectures:	Monday, Wednesday and Friday 11.10-12.00
Practical class:	Monday, Tuesday, Thursday and Friday 14.10-17.00

Syllabus

Section 1: The Tools of the Trade
This introductory section explores what Physics is and reviews the key tools (mental, not metal) needed in the practice of Physics.
1.1 The trade: what is Physics?
1.2 Units
1.3 Numbers
1.4 Vectors
1.5 Problem solving

Section 2: Space and Time
Physics deals with the sequence of events that make up the unfolding story of the universe. The most basic questions we can ask about 'events' are 'where?' and 'when?' Thus Space and Time are the key concepts of physics. In this section we explore the classical view of Space and Time developed by Galileo and Newton, and touch on its failures, unearthed by Einstein.
2.1 One dimensional particle kinematics
2.2 Kinematics in two (or three) dimensions
2.3 Application: projectile motion
2.4 Application: circular motion
2.5 Relativity: the common sense view
2.6 Relativity: Einstein's view

Section 3: Force Mass and Motion
Understanding a changing world means understanding motion. This section is concerned with the key concepts (mass, force) underlying the classical Newtonian theory of motion, and expressed in Newton's three laws. We illustrate the application of these laws in the context of a wide range of forces, and touch on some of the curious 'forces' encountered in 'accelerating' reference frames.
3.1 Inertial reference frames: Newton's 1st Law
3.2 Force and mass: Newton's 2nd and 3rd laws
3.3 How to use Newton's Laws
3.4 Classification of forces
3.5 Gravitational force near the earth's surface
3.6 Normal contact force
3.7 Tension
3.8 Frictional force
3.9 Linear restoring force
3.10 The centripetal force
3.11 The gravitational force
3.12 The electrostatic force
3.13 Fictitious forces

Section 4: Energy and Work
To describe the changing world around us, we must describe its state. Energy is one of the key tools that allow us to do this. In this section we explore the concept of energy: its definition, its conservation and its utility in problem solving.
4.1 Introduction
4.2 Work
4.3 Power: the rate of working
4.4 Kinetic energy
4.5 Potential energy
4.6 Potential energy: examples
4.7 Energy conservation

Section 5: Linear Momentum
The concept of the linear momentum of a system of particles is an extremely fruitful one in many areas of physics. In this section we develop the tools needed to describe the motion of such a system, and deduce that momentum must be conserved for an isolated system. This allows us to analyse elastic and inelastic collisions. We will also look at what happens to our view of mass, momentum and energy for objects moving at very high speeds.
5.1 Preview
5.2 Systems of particles
5.3 Motion of the centre of mass
5.4 Linear momentum
5.5 Linear momentum and its conservation
5.6 Collisions
5.7 Relativity: Mass, Momentum and Energy

Section 6: Angular Momentum
In this section we develop concise methods of describing rotational motion using quantities such as angular velocity, angular momentum and moment of inertia, the rotational analogues of velocity, momentum and mass. Using this new language, we can describe such counterintuitive phenomena as the behaviour of spinning tops and gyroscopes, and find out why it is easier to ride a bicycle with bigger wheels.
6.1 Linear and rotational motion
6.2 Angular positions, velocities and accelerations
6.3 Relations between angular and linear quantities
6.4 Constant acceleration equations
6.5 Kinetic energy of a rotating body: moment of inertia
6.6 Torque
6.7 Angular momentum
6.8 Angular momentum conservation

Section 7: Oscillations
Understanding and exploiting oscillations is central to many aspects of science including physics, chemistry, biology and engineering. In this section we will set out the key concepts, and explore them in the context of a wide range of examples. We shall end up in chaos.
7.1 Introduction: what and why
7.2 Simple Harmonic Motion: the physical context
7.3 The SHM equation: a general tour
7.4 The SHM equation: applications
7.5 Energy conservation in SHM
7.6 Driving and damping
7.7 Chaos

Recommended reading

'Principle of Physics' (Extended International Edition; 10th Edition, authors: Halliday, Resnick and Walker, publisher: Wiley

Contacts

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PHYS08017 Physics 1B: The Stuff of the Universe

Course Organiser:	ROSS GALLOWAY	**Other Key Staff:**	
Course Secretary:	DAWN HUTCHEON	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description

The course begins with the classical models of particles and waves and their relationship to the physical world of atoms and light. Quantum physics is introduced through the idea of wave/particle duality, in a largely non-mathematical way. The uncertainty principle, Schrodinger's cat and quantum tunnelling are discussed. The hydrogen atom, and then more complex atoms are considered illustrating the role of quantum effects such as the Pauli exclusion principle which is seen to underly the structure of the periodic table. The phases of matter are discussed and quantum effects are used to explain ordinary conductivity and superconductivity. Matter is explored at the nuclear and elementary particle scales. At large scales the behaviour of stars and of the big-bang are related to the fundamental properties of matter.

Learning Outcomes

i) demonstrate a general appreciation for the microscopic origin of many everyday macroscopic phenomena, for example pressure and temperature
ii) demonstrate a general understanding of light in terms of atomic transitions, including atomic spectra, lasers and fluorescence/phosphorescence.
iii) describe wave phenomena using appropriate terminology and formulae, for example in the situations of wave propagation, diffraction and interference
iv) demonstrate a reasonable understanding of the fundamental aspects of quantum mechanics, specifically including wave-particle duality, the photoelectric effect, two-slit experiments, the role of the observer and quantum tunnelling.
v) determine basic parameters associated with a variety of simple potential wells.
vi) demonstrate the significance of the Pauli Exclusion Principle, especially in relation to an understanding of the Periodic Table of Elements and chemical properties.
vii) demonstrate a basic understanding of the band theory of crystalline solids, exploring applications such as semiconductors and superconductors.
viii) demonstrate basic knowledge of nuclear and particle physics; radioactive decay, the standard model and neutrinos.
ix) demonstrate a reasonable understanding of modern cosmology, including the Big Bang theory , stellar evolution, cosmic expansion, dark matter, and the ultimate fate of the Universe.
x) show competence in a scientific laboratory.
xi) show an understanding for the various sources of uncertainty incurred in making any experimental measurement. Furthermore, they should be able to estimate such experimental errors and be able to reasonably determine the incurred uncertainty in a derived quantity.
xii) communicate scientific concepts in a written format

Opportunities for feedback

See specific Course Handbook for details

Assessment details

Written Exam 60 %, Coursework 20 %, Practical Exam 20 %
See specific Course Handbook for details

Assessment deadlines

See specific Course Handbook for details

Pre-requisite courses

SCE Higher Grade Physics and Mathematics (at Grade A) or equivalent.

Timetable

Semester:	Semester 2
Lectures:	Monday, Wednesday and Friday 11.10-12.00
Practical class:	Monday, Tuesday, Thursday and Friday 14.10-17.00

Tutorial: Tutorials one hour per week, as arranged.

Syllabus

Part I: Particles, Waves and Quanta

1. The Classical Particle Picture
- Brownian motion. Monatomic gases. Avogadro's number. Pressure. The Ideal Gas Law.
- Temperature. Mean free path and rms velocity. Kinetic Energy and Heat. The Maxwell-Boltzmann distribution.
- Heat Capacity of a monatomic gas. Molecular gases. Rotational and vibrational modes. Equipartition of energy.

2. The Classical Wave Picture
- Introduction to waves.
- Sound Waves. Velocity of sound. Relationship to properties of matter.
- Light. Spectrum of Electromagnetic waves. Velocity of light in a vacuum. Wave-fronts and Huygens' Principle.
- Superposition of waves. Interference. Phase difference.
- Diffraction by a single slit. Young's double slits. Diffraction grating. X-ray diffraction.

3. The Quantum World
- The Photoelectric Effect. Planck's constant. The Photon. Quantisation of Energy.
- Diffraction of electrons. Diffraction of neutrons and atoms. The de Broglie wavelength.
- Wave particle duality. The wave function. Wave packets. The uncertainty principle.
- The probability density interpretation of the wave function. Schrödinger's cat. The role of the observer. The quantum interpretation of the double slit experiment.

Part II: Atoms, Molecules and Solids

1. Elementary Quantum Mechanics
- Schrödinger's equation. Solutions for a free particle, and a particle in a box.
- Potential wells. Energy levels in an infinite well and in a harmonic well.
- Effect of a step potential. The finite barrier. Quantum tunnelling.

2. The Hydrogen Atom
- A review of classical circular orbits. The Bohr model. Energy dependence of radius. Limitation of classical picture.
- Quantisation of angular momentum and energy. Electron spin. Wave functions and probability distributions. Energy levels.
- Absorption and emission of photons. Bohr frequency condition. Spectral lines for Hydrogen. Allowed and forbidden transitions. Line widths and lifetimes.

3. Complex Atoms and Molecules
-Multi-electron atoms. Energy level diagrams and spectral lines. The Pauli exclusion principle. Fermions and bosons. Orbitals. The periodic table of elements.
- Stimulated emission. Population inversion and amplification. The Helium-Neon laser.

- The hydrogen molecule. Splitting of single electron energy levels. The covalent bond. Brief discussion of other types of bonds.

4. The Solid State
- The phases of matter. Gases, liquids and solids. Crystalline and amorphous materials. Crystal structure.
- Energy bands. Insulators and metals. Filled and unfilled bands. The Fermi level. Conduction of electricity in metals.
- Semiconductors. Conduction and valence bands. Electrons and holes. Doping. The pn junction and the laser diode.
- Superfluid Helium. Bosons don't obey exclusion principle. Condensation into a collective ground state. Cooper pairs and superconductivity.

Part III: The Stuff of the Universe

1. The Atomic Nucleus
- Discovery of the nucleus. The nuclear scale. High energy electron scattering. The nucleon-nucleon interaction. Mass and Binding Energy (E=mc2).
- Radioactive decays: The radioactive decay law. Alpha, beta and gamma decays. Energy released in nuclear decays.
- Nuclear reactions: Nuclear instability, Nuclear fission (spontaneous and induced) and Nuclear fusion (nucleosynthesis and thermonuclear).

2. Elementary Particles
- Introduction to elementary particles. Quantum field theory. Antiparticles. The muon and pion. The particle explosion.
- The Standard Model. The eightfold way and quarks. Quantum chromodynamics. Quark confinement. Evidence for quarks. The weak interaction. Leptons. The fundamental forces.
- Conservation laws and particle decays: Crossing symmetry, conservation of charge, baryon number & lepton number. Strangeness. Particle decays and widths. Strength of the forces.

3. Matter in the Universe
- The expanding universe: Doppler effect, red-shift. Hubble's Law. The critical density.
- Dark matter. Dark energy. The cosmic microwave background. The Big Bang. Unification of forces.

Recommended reading

'Principle of Physics' (Extended International Edition; 10th Edition, authors: Halliday, Resnick and Walker, publisher: Wiley)

Contacts

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PHYS08035 Mathematics for Physics 1

Course Organiser:	Kristel Torokoff	**Other Key Staff:**	
Course Secretary:	Rhona Johnston	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description

This course is designed for pre-honours physics students, primarily to develop their mathematical and problem solving skills in the context of basic algebra and calculus. A key element in understanding physics is the ability to apply elementary mathematics effectively in physical applications. For this, knowledge of mathematics is not enough, one also needs familiarity and practice. The course is centred on problem solving workshops, and supported by lectures.

Learning Outcomes

- Demonstrate understanding and work with basic algebra: manipulating algebraic expressions, completing squares, polynomials and factor theorem, quadratic and root equations.
- Demonstrate understanding and work with functions: inequalities, modulus functions, exponential and logarithms, curve sketching, series expansions, harmonic potentials.
- Demonstrate understanding and work with geometry and trigonometry: trigonometric functions, lines and circles, conic sections.
- Demonstrate understanding and work with complex numbers: algebra with i, argand diagram, Euler and de-Moivre, trigonometric functions revisited.
- Demonstrate understanding and work with derivatives: differentiate standard functions, differentiate composite functions, higher derivatives, applications to simple physical problems.
- Demonstrate understanding and work with integrals: standard integrals, integrating by substitution, integrating by parts.

Opportunities for feedback

See specific Course Handbook for details

Assessment details

Written Exam 80 %, Coursework 20 %, Practical Exam 0 %
See specific Course Handbook for details

Assessment deadlines

See specific Course Handbook for details

Pre-requisite courses

It is RECOMMENDED that students also take Physics 1A: Foundations (PHYS08016)

Timetable

Semester:	Semester 1
Lectures:	Tuesday and Friday 13.10-14.00
Practical class:	N/A
Tutorial:	Monday and Thursday 14.10-16.00 Tuesday and Thursday 09.00-10.50

Syllabus

1. Basic algebra: manipulating algebraic expressions, completing squares, polynomials and factor theorem, quadratic and root equations.
2. Functions: inequalities, modulus functions, exponential and logarithms, curve sketching.
3. Series expansion
4. Trigonometry: trigonometric functions, algebra with trigonometric functions.
5. Complex numbers: algebra with i, Argand diagram, Euler and de-Moivre, trigonometric functions revisited.
6. Differentiation: differentiate standard functions, composite functions, higher derivatives, applications.
7. Integration: standard integrals, integrating by substitution, integrating by parts, applications.

Recommended reading

See specific Course Handbook for details

Contacts

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PHYS08036 Mathematics for Physics 2

Course Organiser:	Kristel Torokoff	Other Key Staff:	
Course Secretary:	Rhona Johnston	Course location:	Kings Buildings
Credits available:	20	SCQF Level:	08

Course description

This course is designed for pre-honours physics students, primarily to further develop their mathematical and problem solving skills in the context of algebra and calculus, with increasing emphasis on physical applications. The aim of the course is to help the students apply mathematics to the solution of typical physics problems, developing fluency and confidence through practical problem solving. The course is centred on problem solving workshops, and supported by lectures.

Learning Outcomes

- Demonstrate understanding and work with differential equations: linear first order, ordinary second order, simultaneous linear DE, the harmonic oscillator, stable and unstable equilibrium.
- Demonstrate understanding and work with vectors and matrices: basic vector and matrix algebra, determinants, inverses, statics, friction, systems of forces, moments, resolving forces into components, Coulomb electrostatics.
- Demonstrate understanding and work with time dependent vectors: velocity and acceleration, Newtonian dynamics, pulleys and springs, energy conservation, work, angular momentum, torque.
- Demonstrate understanding and work with curvilinear motion: tangents, cartesian and polar coordinates, dynamics in polar co-ordinates, circular motion, projectiles.

Opportunities for feedback

See specific Course Handbook for details

Assessment details

Written Exam 80 %, Coursework 20 %, Practical Exam 0 %

See specific Course Handbook for details

Assessment deadlines

See specific Course Handbook for details

Pre-requisite courses

It is RECOMMENDED that students have passed Physics 1A: Foundations (PHYS08016)

Students MUST have passed: Mathematics for Physics 1 (PHYS08035) OR Introduction to Linear Algebra (MATH08057)

Timetable

Semester:	Semester 2
Lectures:	Tuesday and Friday 13.10-14.00
Practical class:	N/A
Tutorial:	Monday and Thursday 14.10-16.00, Tuesday and Thursday 09.00-10.50

Syllabus

The focus of this course will be the application of mathematics to simple physics problems.

1. Vector Algebra (addition, subtraction, scalar and cross product, determinants)
2. Simultaneous Linear Equations
3. Matrix Algebra and Determinants
4. Differentiating and Integrating Vectors
5. First Order Ordinary Differential Equations
6. Polar Coordinates (planar polar, spherical, normal/tangential)
7. Applications on simple Statics and Dynamics problems
8. Second Order Ordinary Differential Equations
9. Harmonic Oscillator
10. Stable and Unstable Equilibrium

Recommended reading

See specific Course Handbook for details

Contacts

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PHYS08043 Dynamics and Vector Calculus

Course Organiser:	Stephen Playfer	**Other Key Staff:**	
Course Secretary:	Bonnie Macmillan	**Course location:**	Kings Buildings
Credits available:	20	**SCQF Level:**	08

Course description
This course is designed for all pre-honours physics students. It covers ordinary differential equations and the techniques of vector calculus, which are used to describe concepts in physics. The course consists of lectures to present new material, and workshops to develop understanding, familiarity and fluency.

Learning Outcomes
- Explain how aspects of the physical world are appropriately modelled in terms of ordinary differential equations and scalar and vector fields.
- Apply standard methods for solving ordinary differential equations and vector calculus to physics problems.
- Present a solution to physics and mathematics problems in a clear and logical written form.
- Assess whether a solution to a given problem is physically and mathematically reasonable
- Locate and use additional sources of information (to include discussion with peers where appropriate) to facilitate independent problem-solving.

Opportunities for feedback
See specific Course Handbook for details

Assessment details
Written Exam 80 %, Coursework 20 %, Practical Exam 0 %
See specific Course Handbook for details

Assessment deadlines
See specific Course Handbook for details

Pre-requisite courses
Students MUST have passed: (Algebra and Calculus (PHYS08041) OR Linear Algebra and Several Variable Calculus (PHYS08042) OR Several Variable Calculus and Differential Equations (MATH08063)) AND (Classical and Modern Physics (PHYS08044) OR Modern Physics (PHYS08045)). Students MUST NOT also be taking Introductory Dynamics (PHYS08052)

Timetable

Semester:	Semester 2
Lectures:	Monday, Tuesday, Thursday and Friday 11.10-12.00
Practical class:	Monday, Tuesday and Thursday 14.10-16.00 Wednesday 9.00-10.50
Tutorial:	N/A

Syllabus
Dynamics (~20 lectures)
Part 1 - Introduction to Dynamics. Ordinary Differential Equations.
Newton's laws. Reference frames. Energy and momentum conservation.
Projectiles. Variable mass problems. Rocket equation. (5)
Part 2 - Simple harmonic motion. Solution of 2nd order differential equations.
Damped SHM. Forced SHM. Coupled oscillations. Normal modes. (5)
Part 3 - Central forces. Angular momentum. Orbits. Kepler's Laws.
Non-inertial frames. Centrifugal & Coriolis forces. (5)
Part 4 - Two-body problem. Centre of Mass system. Scattering.
Rigid bodies. Torque. Moments of inertia. (4)
+ Introduction to Lagrangian dynamics (optional topic, time permitting)

Vector Calculus (20 lectures)

- Introduction to fields. Equipotentials. Scalar and vector fields. (3)
- Gradient. Divergence. Curl. Laplacian operator. Vector operator identities.(4)
- Plane surfaces. Line, surface and volume elements. Line integrals. Surface integrals. Volume integrals. (5)
- Divergence Theorem. Continuity equation. Stokes¿s Theorem. (3)
- Scalar potential. Conservative forces and fields. Poisson¿s equation. Vector potential.(3)
- Curvilinear surfaces. Line, surface, volume elements. Div, grad, curl in polar coordinates.(2)

Recommended reading

For the whole of this course the mathematical methods are covered in:
``Mathematical Methods for Physics and Engineering'', K. F. Riley, M. P. Hobson, S. J. Bence, Cambridge University Press (1998)
``Mathematical Methods in the Physical Sciences,'' Mary L. Boas, Published by John Wiley and Sons, Inc.(1966)

The Dynamics part of the course is closest to the material in:
``Classical Mechanics,'' R. Douglas Gregory, Cambridge University Press (2006)
Also useful are:
``Introduction to Classical Mechanics,'' A.P.French & M.G.Ebison (1987)
``Analytical Mechanics," G.R.Fowles & G.L.Cassiday, 7th Edition, Brookes/Cole (2005)
``Classical Mechanics," John R. Taylor, UCB (2005)
The first half of: ``Dynamics and Relativity,'' W.D.McComb, Oxford University Press (1999)
and for SHM: ``Vibrations and Waves,'' A.P.French, CRC Press (1971)

The Vector Calculus part of the course will not use any particular textbook. The first two listed below are standard texts; Spiegel contains many examples and problems:

DE Bourne and PC Kendall, Vector Analysis and Cartesian Tensors, (Chapman and Hall).
PC Matthews, Vector Calculus, (Springer).
MR Spiegel, Vector Analysis, (Schaum, McGraw-Hill).

Contacts

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PHYS08042 Linear Algebra and Several Variable Calculus

Course Organiser:	Philip Clarke	**Other Key Staff:**	
Course Secretary:	Bonnie Macmillan	**Course location:**	Kings Buildings
Credits available:	10	**SCQF Level:**	08

Course description

This course is designed for pre-honours physics students continuing from PH1. It covers linear algebra and multivariate calculus, which are used to describe concepts in physics. The course consists of lectures to present new material, and workshops to develop understanding, familiarity and fluency.

Learning Outcomes

- Show fluency and confidence in linear algebra and several variable calculus, as they apply to physical problems.
- Present a solution to a physics problem in a clear and logical written form
- Assess whether a solution to a given problem is physically reasonable
- Locate and use additional sources of information (to include discussion with peers and use of computer algebra packages where appropriate) to facilitate independent problem-solving
- Take responsibility for learning by attending lectures and workshops, and completing coursework

Opportunities for feedback

See specific Course Handbook for details

Assessment details

Written Exam 80 %, Coursework 20 %, Practical Exam 0 %

See specific Course Handbook for details

Assessment deadlines

See specific Course Handbook for details

Pre-requisite courses

Students MUST have passed: (Physics 1A: Foundations (PHYS08016) AND Physics 1B: The Stuff of the Universe (PHYS08017) AND Mathematics for Physics 1 (PHYS08035) AND Mathematics for Physics 2 (PHYS08036)) OR (Physics 1A: Foundations (PHYS08016) AND Mathematics for Physics 2 (PHYS08036) AND Introduction to Linear Algebra (MATH08057) AND Calculus and its Applications (MATH08058). Students MUST NOT also be taking Algebra and Calculus (PHYS08041)

Timetable

Semester:	Semester 1
Lectures:	Tuesday and Friday 12.10-13.00
Practical class:	Tuesday and Friday 14.10-16.00
Tutorial:	N/A

Syllabus

- Vectors. Basic vector algebra. (1)
- Dot and cross products. Triple products. (3)
- Linear independence. Expansion in a basis. Change of basis. (1)
- Matrices. Matrix algebra. Orthogonal transformations. (3)
- Determinant, rank and inverse. Eigenvalues and eigenvectors. Matrix diagonalisation(4)
- Complex vectors. Hermitian and unitary matrices. (2)
- Taylor expansions. Maxima, minima and saddle points (1)
- Partial derivatives. Chain rule. Change of variables. Spherical and cylindrical polar coordinates. (3)
- Multivariate integration. (2)

Recommended reading

See specific Course Handbook for details

Contacts

Course Organiser
Philip Clarke
Email: P.Clark@ed.ac.uk
Tel: 0131 650 5231

Course Secretary
Bonnie Macmillan
Email: Bonnie.MacMillan@ed.ac.uk
Tel: 0131 650 7218

PHYS08045 Modern Physics

Course Organiser:	Alex Murphy	**Other Key Staff:**	
Course Secretary:	Peter Hodkinson	**Course location:**	Kings Buildings
Credits available:	10	**SCQF Level:**	08

Course description
This course is designed for pre-honours physics students continuing from PH1. It provides an introduction to special relativity and quantum physics. It serves both as a preparation for further study in physics-based degree programmes, and as a stand-alone course for students of other disciplines, including mathematics, chemistry, geosciences, computer science and engineering. The course consists of lectures to present new material, and workshops to develop understanding, familiarity and fluency.

Learning Outcomes
- State the basic principles of special relativity and elementary quantum mechanics and the regimes in which the different theories apply
- Apply these principles in conjunction with elementary mathematical techniques to solve simple problems in relativistic and quantum mechanics
- Present a solution to a physics problem in a clear and logical written form
- Assess whether a solution to a given problem is physically reasonable
- Locate and use additional sources of information (to include discussion with peers where appropriate) to facilitate independent problem-solving
- Take responsibility for learning by attending lectures and workshops, and completing coursework

Opportunities for feedback
See specific Course Handbook for details

Assessment details
Written Exam 80 %, Coursework 20 %, Practical Exam 0 %
See specific Course Handbook for details

Assessment deadlines
See specific Course Handbook for details

Pre-requisite courses
Students MUST have passed: (Physics 1A: Foundations (PHYS08016) AND Mathematics for Physics 2 (PHYS08036)) OR (Physics 1A: Foundations (PHYS08016) AND Introduction to Linear Algebra (MATH08057) AND Calculus and its Applications (MATH08058)). Students MUST NOT also be taking Classical and Modern Physics (PHYS08044) OR Classical Physics (PHYS08055)

Timetable

Semester:	Semester 2
Lectures:	Monday and Thursday 9.00-9.r50
Practical class:	Tuesday and Friday 10.00-12.00
	Wednesday 11.00-13.00
Tutorial:	N/A

Syllabus
Modern Physics (20 lectures)

*Special Relativity (10 lectures)
- Definition of inertial reference frames and invariance of speed of light,(postulates of SR). Michelson Morley experiment. Role of the observer. (2)
- Time effects and the concept of time dilation and Lorentz contraction. Events. Synchronisation. Moving clocks. Synchronised clocks in one frame viewed from another moving frame. (2)
- Doppler (red shift) and its implications, Gamma, addition of velocities. Twins paradox. Rod and Shed paradox. (2)

- Geometric formulation of SR (Minkowski Diagrams), and their relation to time dilation, Lorentz contraction, order of events, relativistic Doppler, world lines, event horizon. (2)
- Momentum and relation to mass and energy as a relativistic property. (2)

*Introduction to Quantum Physics (10 lectures)
- Planck's Radiation formula (1)
- Photoelectric Effect, Einstein's photon theory (1)
- Rutherford scattering (1)
- Compton Effect (1)
- Bohr-Sommerfeld quantization condition; Bohr Atom (1)
- Discussion of atomic spectra (1)
- Correspondence Principle, De Broglie relations between waves and particles, Uncertainty Principle (1)
- First look at Schrodinger's equation. Meaning of wavefunction, probability interpretation, probability current. (1)
- First look at solving Schrodinger's equation for particle in a box (2)

Recommended reading

See specific Course Handbook for details

Contacts

Course Organiser
Alex Murphy
Email: a.s.murphy@ed.ac.uk
Tel: 0131 650 5285

Course Secretary
Peter Hodkinson
Email: peter.hodkinson@ed.ac.uk
Tel: 0131 650 5254

Geophysics (BSc Hons) (UTGEOPY) / Geophysics (MEarthPhys) (UTMEPGEOPH1F)

Year 1

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC08001	Earth Dynamics	Semester 1	20
EASC08008	Introduction to Geophysics	Semester 2	20
PHYS08016	Physics 1A: Foundations	Semester 1	20
PHYS08017	Physics 1B: The Stuff of the Universe	Semester 2	20
PHYS08035	Mathematics for Physics 1	Semester 1	20
PHYS08036	Mathematics for Physics 2	Semester 2	20

COURSE OPTIONS

There are no optional courses available in year 1 of this degree programme.

Year 2

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC08016	Physics of the Earth	Semester 2	20
EASC08020	Global Tectonics and the Rock Cycle	Semester 2	20
PHYS08043	Dynamics and Vector Calculus	Semester 2	20

COURSE OPTIONS

Select exactly 60 credits from
20 Credits from Level 7/8 courses in Schedules A to Q T and W, as available.
AND
40 credits from:
EASC08022 Earth Science Fundamentals for Geophysicists (10 credits)
PHYS08041 Algebra and Calculus (20 credits)
PHYS08055 Classical Physics (10 credits)

OR

Select exactly 60 credits from
40 credits from Level 7/8 courses in Schedules A to Q T and W, as available.
AND
20 credits from:
PHYS08045 Modern Physics (10 credits)
PHYS08042 Linear Algebra and Several Variable Calculus (10 credits)

Year 3

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC09054	Mathematical and computational methods in Geophysics	Semester 1	20
EASC09052	Structural Analysis of Rocks and Regions (SARR)	Semester 2	20
EASC10108	Petroleum Systems	Semester 1	20
EASC10110	Geophysical Measurement and Modelling	Semester 2	20
EASC10109	Geophysical Imaging and Inversion	Semester 2	20
EASC09055	Research Training for Geophysics	Full Year	20

COURSE OPTIONS

There are no optional courses available in year 3 of this degree programme.

Year 4

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC10035	Seismology	Semester 1	10
EASC10036	Geomagnetism	Semester 1	10
EASC10037	Global Geophysics	Semester 2	10
EASC10038	Exploration Seismology	Semester 2	10
EASC10111	Geophysics International Field Course	Full Year	10

COURSE OPTIONS

Select exactly 40 credits from
EASC10052 Geophysics Project 1 (20 credits)
EASC10053 Geophysics Project 2 (20 credits)
EASC10065 Geophysics Project (40 credits)

AND

Select exactly 10 credits from
School of Physics and Astronomy Level 9 courses, as available.
Earth Science Level 10 and 11 courses, as available.

AND

Select exactly 20 credits from
Earth Science Level 10 and 11 courses, as available.
EASC11003 Controlled Source Electro-Magnetic (CSEM) Methods (10 credits)
ENVI11002 Introduction to Three Dimensional Climate Modelling (10 credits)

Year 5 (MEarthSci students only)

COMPULSORY COURSES

Code	Course Name	Period	Credits
GESC11001	Project Design and Literature Analysis	Semester 1	20
GESC11002	Geoscience Research Project	Full Year	40
GESC11003	Frontiers in Earth Science	Semester 2	10
EASC11005	Scientific Computing Skills	Semester 1	20

COURSE OPTIONS

Select exactly 30 credits from
Earth Science Level 10 and 11 courses, as available.

Geophysics and Geology (BSc Hons) (UTGEOGEO) / Geophysics and Geology (MEarthPhys) (UTMEPGEOGE1F)

Year 1

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC08001	Earth Dynamics	Semester 1	20
EASC08008	Introduction to Geophysics	Semester 2	20
PHYS08016	Physics 1A: Foundations	Semester 1	20
PHYS08017	Physics 1B: The Stuff of the Universe	Semester 2	20
PHYS08035	Mathematics for Physics 1	Semester 1	20
PHYS08036	Mathematics for Physics 2	Semester 2	20

COURSE OPTIONS

There are no optional courses available in year 1 of this degree programme.

Year 2

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC08016	Physics of the Earth	Semester 2	20
EASC08020	Global Tectonics and the Rock Cycle	Semester 2	20
EASC08017	Introduction to the Geological Record	Semester 2	20
PHYS08045	Modern Physics	Semester 1	10
PHYS08042	Linear Algebra and Several Variable Calculus	Semester 1	10
EASC08021	Geomaterials	Semester 1	20

COURSE OPTIONS

Select exactly 20 credits from Level 7/8 courses in Schedules A to Q T and W, as available.

Year 3

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC09054	Mathematical and computational methods in Geophysics	Semester 1	20
EASC09052	Structural Analysis of Rocks and Regions (SARR)	Semester 2	20
EASC10108	Petroleum Systems	Semester 1	20
EASC10110	Geophysical Measurement and Modelling	Semester 2	20
EASC10105	Field Skills for Geology	As available	20
EASC09055	Research Training for Geophysics	Full Year	20

COURSE OPTIONS

There are no optional courses available in year 3 of this degree programme.

Year 4

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC10111	Geophysics International Field Course	Full Year	10
EASC10090	Evolution of the Modern Earth	Semester 1	10
EASC10089	Frontiers in Research	Semester 2	10
EASC10037	Global Geophysics	Semester 2	10
EASC10038	Exploration Seismology	Semester 2	10

COURSE OPTIONS

Select exactly 40 credits from EASC10052 Geophysics Project 1 (20 credits) EASC10053 Geophysics Project 2 (20 credits)

EASC10065 Geophysics Project (40 credits) EASC10011 Geology Dissertation (40 credits) AND **Select exactly 30 credits from** Earth Science Level 10 and 11 courses, as available.

Year 5 (MEarthSci students only)

COMPULSORY COURSES

Code	Course Name	Period	Credits
GESC11001	Project Design and Literature Analysis	Semester 1	20
GESC11002	Geoscience Research Project	Full Year	40
GESC11003	Frontiers in Earth Science	Semester 2	10

COURSE OPTIONS

Select exactly 30 credits from Earth Science Level 10 and 11 courses, as available AND **Select exactly 20 credits from** EASC11005 Scientific Computing Skills (20 credits) GESC11004 MEarthSci Field Training (20 credits)

Geophysics and Meteorology (BSc Hons) (UTGEOME) / Geophysics and Meteorology (MEarthPhys) (UTMEPGEOME1F)

Year 1

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC08001	Earth Dynamics	Semester 1	20
EASC08008	Introduction to Geophysics	Semester 2	20
PHYS08016	Physics 1A: Foundations	Semester 1	20
PHYS08017	Physics 1B: The Stuff of the Universe	Semester 2	20
PHYS08035	Mathematics for Physics 1	Semester 1	20
PHYS08036	Mathematics for Physics 2	Semester 2	20

COURSE OPTIONS

There are no optional courses available in year 1 of this degree programme.

Year 2

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC08016	Physics of the Earth	Semester 2	20
PHYS08043	Dynamics and Vector Calculus	Semester 2	20
METE08001	Meteorology: Atmosphere and Environment	Semester 1	20
METE08002	Meteorology: Weather and Climate	Semester 2	20

COURSE OPTIONS

Select exactly 40 credits from
20 credits from Level 7/8 courses in Schedules A to Q T and W, as available.
AND
20 credits from
PHYS08042 Linear Algebra and Severable Variable Calculus (10 credits)
PHYS08045 Modern Physics (10 credits)

OR

Select exactly 40 credits from
EASC08022 Earth Science Fundamentals for Geophysicists (10 credits)
PHYS08041 Algebra and Calculus (20 credits)
PHYS08055 Classical Physics (10 credits)
(NB: Courses compulsory for direct entry to second year students)

Year 3

COMPULSORY COURSES

Code	Course Name	Period	Credits
PHYS09021	Thermodynamics	Semester 1	10
EASC09054	Mathematical and computational methods in Geophysics	Semester 1	20
EASC10102	Earth's Atmospheric Composition	Semester 2	20
METE10006	Atmospheric Science Field Skills	Semester 1	10
EASC10110	Geophysical Measurement and Modelling	Semester 2	20
EASC10109	Geophysical Imaging and Inversion	Semester 2	20
EASC09055	Research Training for Geophysics	Full Year	20

COURSE OPTIONS

There are no optional courses available in year 3 of this degree programme.

Year 4

COMPULSORY COURSES

Code	Course Name	Period	Credits
EASC10111	Geophysics International Field Course	Full Year	10
METE10001	Atmospheric Dynamics	Semester 1	10
METE10002	Atmospheric Physics	Semester 1	10

COURSE OPTIONS

Select exactly 40 credits from EASC10052 Geophysics Project 1 (20 credits) EASC10053 Geophysics Project 2 (20 credits) EASC10065 Geophysics Project (40 credits) AND **Select exactly 30 credits from** A maximum of 10 credits from School of Physics and Astronomy Level 9 courses, as available. A maximum of 30 credits from Level 10/11 courses in Schedules A to Q T and W, as available. A maximum of 20 credits from Earth Science Level 10 and 11 courses, as available AND **Select exactly 20 credits from** Earth Science Level 10 and 11 courses, as available. AND **Select a maximum of 10 credits from** METE10003 Physics of Climate (10 credits) (NB: If METE10003 is not taken in Junior Honour year, it must be taken in Senior Honours year)

Year 5 (MEarthSci students only)

COMPULSORY COURSES

Code	**Course Name**	**Period**	**Credits**
GESC11001	Project Design and Literature Analysis	Semester 1	20
GESC11002	Geoscience Research Project	Full Year	40
GESC11003	Frontiers in Earth Science	Semester 2	10
EASC11005	Scientific Computing Skills	Semester 1	20
ENVI11002	Introduction to Three Dimensional Climate Modelling	Semester 1	10

COURSE OPTIONS

Select exactly 20 credits from

EASC11003	Controlled Source Electro-Magnetic (CSEM) Methods	10
ENVI11002	Introduction to Three Dimensional Climate Modelling	10
PGGE11053	Fundamentals for Remote Sensing	10
PGGE11064	Introduction to Radar Remote Sensing	10
PGGE11040	Hyperspectral Remote Sensing	10

OR

Select exactly 20 credits from

EASC10102 Earth’s Atmospheric Composition (20 credits)

Additional information

This section details any further information that may be helpful to you during the fourth (SH) year of your degree programme

Project talks

You will be required to give an assessed 15-minute presentation in innovative learning week. The subject of your presentation should be your S1 project (which you will have finished) or your whole-year project (which you will still be working on). The marks for your presentation form part of the mark for “Geophysics International Field Course”; they are not part of the mark for your project.

Useful links

The below links are for pages which give details of policies and guidance within and outside of the School of GeoSciences, including Special Circumstances, Assessments and Examination diets.

School of GeoSciences Teaching Organisation:
http://www.ed.ac.uk/schools-departments/geosciences/teaching-organisation

School of GeoSciences policies and forms:
http://www.ed.ac.uk/schools-departments/geosciences/teaching-organisation/to-form-policy

College of Science and Engineering:
http://www.ed.ac.uk/schools-departments/science-engineering

Academic Services:
http://www.ed.ac.uk/schools-departments/academic-services