Geophysics (Physics) BSc (Hons)

COURSE DETAILS

- A level requirements: **ABB**
- UCAS code: **F656**
- Study mode: Full-time
- Length: 3 years

KEY DATES

- Apply by: **25 January 2023**
- Starts: **25 September 2023**

Course overview

Discover how planet Earth works and how we use physics to image its static and dynamic subsurface, from inner core to crust.

INTRODUCTION

This programme provides training in the principles and practice of geophysics with an emphasis on pure and practical physics.

The programme will cover core topics in physics, geophysics, geoscience and mathematics, plus a choice of advanced modules in geophysics. Major features include training in practical geophysics, exploration geophysics (particularly seismology), planetary-scale geophysics and geophysical inverse theory.

High-level training is given in geophysics with supporting physics, providing classical physics training to second year university level, and includes university training in geoscience and mathematics.

You will work within one of our research groups to undertake a significant geophysical research project in your final year. This provides excellent training in research methodology for an academic or industrial research career.

Upon completion of your first year, it is possible to transfer to a Physics degree at the end of year one.

A number of the School’s degree programmes involve laboratory and field work. Fieldwork is carried out in various locations, ranging from inner city to coastal and mountainous environments. We consider applications from prospective disabled students on the same basis as all other students, and reasonable adjustments will be considered to address barriers to access.
WHAT YOU’LL LEARN

- Computational physics
- Dynamics and relativity
- Thermal physics
- Properties of matter
- Structure and plate tectonics

- Wave phenomena
- Exploration and environmental geophysics
- Data modelling
- Signal processing and seismic analysis

ACCREDITATION

This degree is recognised by the Institute of Physics.
Course content
Discover what you’ll learn, what you’ll study, and how you’ll be taught and assessed.

YEAR ONE
Students build fundamental skills in maths and physics in year one, with an introduction to core geoscience topics and Earth history. This is supported by an integrated approach to transferable skills conveyed through the tutorial system. Fieldwork involves:

1 day in North England (Autumn)

COMPULSORY MODULES

STUDY SKILLS (GEOPHYSICS (PHYSICS)) (ENVS106)
Credits: 7.5 / Semester: whole session
This module introduces students to the key skills necessary to succeed on the Geophysics (Physics) course. It does this via a series of lectures, workshops and tutorials, together with a field day and attendance at departmental seminars and talks.

Lectures cover writing skills as well as exam preparation. The workshops cover IT skills. The small-group tutorials are run 3 times each semester to support the lecture and workshop programme. The tutors also undertake personal development planning (PDP) with each tutee. The field day visits a local place of geological interest early in the first semester and provides information for the formative essay.

Attendance at departmental seminars helps students integrate into the department and understand the sorts of research that takes place.

INTRODUCTION TO COMPUTATIONAL PHYSICS (PHYS105)
Credits: 7.5 / Semester: semester 1
The “Introduction to computational physics” (Phys105) module is designed to introduce physics students to the use of computational techniques appropriate to the solution of physical problems. No previous computing experience is assumed. During the course of the module, students are guided through a series of structured exercises which introduce them to the Python programming language and help them acquire a range of skills including: plotting data in a variety of ways; simple Monte Carlo techniques; algorithm development; and basic symbolic manipulations. The exercises are based around the content of the first year physics modules, both encouraging students to recognise the relevance of computing to their physics studies and enabling them to develop a deeper understanding of aspects of their first year course.

DYNAMICS AND RELATIVITY (PHYS101)
Credits: 15 / Semester: semester 1
The module provides an overview of Newtonian mechanics, continuing on from A-level courses. This includes: Newton's laws of motion in linear and rotational circumstances, gravitation and Kepler's laws of planetary motion. The theory of Relativity is then introduced, starting from a historical context, through Einstein's postulates, leading to the Lorentz transformations.

**MATHEMATICS FOR PHYSICISTS I (PHYS107)**
**Credits: 15 / Semester: semester 1**
This module aims to provide all students with a common foundation in mathematics, necessary for studying the physical sciences and maths courses in later semesters. All topics will begin "from the ground up" by revising ideas which may be familiar from A-level before building on these concepts. In particular, the basic principles of differentiation and integration will be practised, before extending to functions of more than one variable.

**THERMAL PHYSICS AND PROPERTIES OF MATTER (PHYS102)**
**Credits: 15 / Semester: semester 1**
Einstein said in 1949 that "Thermodynamics is the only physical theory of universal content which I am convinced, within the areas of applicability of its basic concepts, will never be overthrown." In this module, different aspects of thermal physics are addressed: (i) classical thermodynamics which deals with macroscopic properties, such as pressure, volume and temperature – the underlying microscopic physics is not included; (ii) kinetic theory of gases describes the properties of gases in terms of probability distributions associated with the motions of individual molecules; and (iii) statistical mechanics which starts from a microscopic description and then employs statistical methods to derive macroscopic properties. The laws of thermodynamics are introduced and applied.

**EARTH STRUCTURE AND PLATE TECTONICS (ENVS112)**
**Credits: 15 / Semester: semester 2**
Module aims:
To introduce students to the structure and composition of the Earth, the Earth's gravitational and magnetic fields, and dynamics within the deep Earth.
To introduce students to the physics of Earth material and the geological time scale.
To introduce students to plate tectonics.

**FOUNDATIONS OF QUANTUM PHYSICS (PHYS104)**
**Credits: 15 / Semester: semester 2**
This module illustrates how a series of fascinating experiments, some of which physics students will carry out in their laboratory courses, led to the realisation that Newtonian mechanics does not provide an accurate description of physical reality. As is described in the module, this failure was first seen in interactions at the atomic scale and was first seen in experiments involving atoms and electrons. The module shows how Newton's ideas were replaced by Quantum mechanics, which has been critical to explaining phenomena ranging from the photo-electric effect to the fluctuations in the energy of the Cosmic Microwave Background. The module also explains how this revolution in physicist's thinking paved the way for developments such as the laser.

**MATHEMATICS FOR PHYSICISTS II (PHYS108)**

**Credits: 15 / Semester: second semester**

This module introduces some of the mathematical techniques used in physics. For example, matrices, differential equations, vector calculus and series are discussed. The ideas are first presented in lectures and then the put into practice in problems classes, with support from demonstrators and the module lecturer. When you have finished this module, you should: Be able to manipulate matrices and use matrix methods to solve simultaneous linear equations. Be familiar with methods for solving first and second order differential equations in one variable. Have a basic knowledge of vector algebra. Have a basic understanding of series, in particular of Fourier series and transforms.

**EARTH MATERIALS (ENVS185)**

**Credits: 15 / Semester: semester 2**

This module will introduce and develop understanding of rock-forming minerals, and other key Earth materials in terms of their environments of formation, occurrence, and abundance. The module will focus on exploring the uses and societal significance of a range of Earth materials, especially those most important for providing sustainable and renewable energy resources and various societal infrastructure. The key practical skill of mineral description, identification and interpretation will be developed and applied throughout the module, to equip students with appropriate skills for many later geoscience modules.

Programme details and modules listed are illustrative only and subject to change.

**YEAR TWO**

In year two, students build on their skill set through further advanced modules in Physics, while building on Mathematics. A strong feature of year two is the introduction of geophysics modules in applied geophysics and seismology.

**COMPULSORY MODULES**

**CONDENSED MATTER PHYSICS (PHYS202)**

**Credits: 15 / Semester: semester 2**
Condensed matter physics (CMP) is the study of the structure and behaviour of matter that makes up most of the things that surround us in our daily lives, including the screen on which you are reading this material. It is not the study of the very small (particle and nuclear physics) or the very large (astrophysics and cosmology) but of the things in between. CMP is concerned with the “condensed” phases of real materials that arise from electromagnetic forces between the constituent atoms, and at its heart is the necessity to understand the behaviour of these phases by using physical laws that include quantum mechanics, electromagnetism and statistical mechanics. Understanding such behaviour leads to the design of novel materials for advanced technological devices that address the challenges that face modern civilization, such as climate change.

**ELECTROMAGNETISM I (PHYS201)**

**Credits: 15 / Semester: semester 1**

The study of classical electromagnetism, one of the fundamental physical theories. Several simple and idealised systems will be studied in detail, developing an understanding of the principles underpinning several applications, and setting the foundations for the understanding of more complex systems. Mathematical methods shall be developed and exercised for the study of physical systems.

**GEOPHYSICAL MATHEMATICS AND POTENTIAL THEORY (ENVS201)**

**Credits: 15 / Semester: whole session**

This module re-enforces and develops mathematical skills from first year level, up to and including solving partial differentiation. Many topics are covered in a short time – the aim is for students to be familiar with the methods and with fluency in application being a bonus.

The second half of the module applies the mathematical methods to the development of potential theory, particularly for studying gravity and magnetism in both cartesian and spherical (planetary) geometry.

**QUANTUM AND ATOMIC PHYSICS I (PHYS203)**

**Credits: 15 / Semester: semester 1**

The course aims to introduce 2nd year students to the concepts and formalism of quantum mechanics. The Schrodinger equation is used to describe the physics of quantum systems in bound states (infinite and finite well potentials, harmonic oscillator, hydrogen atoms, multi-electron atoms) or scattering (potential steps and barriers). Basis of atomic spectroscopy are also introduced.

**SEISMOLOGY AND COMPUTING (ENVS229)**

**Credits: 15 / Semester: semester 2**
This module introduces students to fundamentals of seismology and computer programming in MATLAB. Students will become familiar with methods used in seismology, types of seismic wave (body waves, surface waves), wave propagation and how to read/interpret seismic data, and earthquake properties. After an introductory two weeks of programming basics, students will then start to write scripts that simulate seismological processes and analyse seismic data. By the end of the module, students should have a good overview of the ways in which seismology is applied in global and exploration geophysics, and in the study of earthquakes.

WAVE PHENOMENA (PHYS103)
Credits: 15 / Semester: semester 2

Waves lie at the heart of physics, being phenomena associated with quantum wave mechanics, electromagnetic fields, communication, lasers and, spectacularly, gravitational waves. The course is divided into several major sections. The first, can be viewed as a pre-wave study of oscillations. This teaches the basics of oscillatory systems which form the backbone of an understanding of waves. The second, deals with waves in abstract; solution of the wave equation and the principles of superposition. Finally, we look at examples of wave phenomena. These are the first introduction to what will be covered in the remainder of your degree.

EXPLORATION GEOPHYSICS (ENVS216)
Credits: 15 / Semester: semester 1

This module provides an introduction to the principles and practise of all the main geophysical methods used for exploration purposes. This includes seismic refraction, seismic reflection, electrical methods, ground penetrating radar, gravity, and magnetics. Students will also gain understanding of when and where each method can be useful. Case studies will be used to highlight application of methods on all scales from shallow to deep, small to large and include uses within archaeology, engineering and geology. The module concludes with a synthesis of methods and how to approach site investigation. The module is lecture and problem session based with 50% continuous assessment from set homework assignments or problem sheets. The final exam constitutes the rest of the assessment.

ENVIRONMENTAL GEOPHYSICS (ENVS258)
Credits: 15 / Semester: semester 2

This module builds on the theory taught in Exploration Geophysics (ENVS216), by introducing a large amount of practical experience, data analysis and interpretation. Fieldwork will be run using input from industry professionals from RSK. The module will introduce principles of remote sensing, and give practical experience in GIS, electrical methods, seismics, ground penetrating radar, gravity and magnetics. Attention will be paid to how these different methods can be integrated to give a thorough understanding of a study site. The module will be assessed through a combination of continuous assessment such as short reports.
YEAR THREE

In Year Three, students focus on advanced Geophysics, with core modules in seismic analysis, and applied geophysics (fieldwork). Optional modules in a range of geophysics modules include topics in global geophysics and geodynamics, data modelling, and earthquake and volcano seismology. Students also undertake a field, laboratory or computer-based geophysics research project for the duration of their final year.

Fieldwork:
• 10 days on the Isle of Man.

COMPULSORY MODULES

SIGNAL PROCESSING AND SEISMIC ANALYSIS (ENVS343)

Credits: 15 / Semester: semester 1

This module will provide an introduction to signal processing and seismic interpretation. The module is taught through a combination of lectures, practical examples during computer-based practical sessions, and self-directed learning. Assessment for the module includes a conference style presentation on the analysis and interpretation of a real-world seismic dataset and a final exam. Successful students will develop understanding of the fundamental concepts and theory of signal processing. They will become familiar with modern seismic data analysis workflows, including correcting and enhancing data, leading to a final geologic interpretation.

GEOPHYSICS FIELD SCHOOL (ENVS362)

Credits: 15 / Semester: semester 2

This module is a practical introduction to a range of techniques in exploration and environmental geophysics, and their application in industry and research. The students receive field-based (or online, where necessary) training in geophysical techniques, including seismic, gravity, magnetic, and electrical methods. During the entire duration of the field class the students will work in teams, and will be required to undertake a geophysical survey. The learning outcomes include developing:

i) knowledge of geophysical instruments and their response to a variety of targets;
ii) an understanding of the principles, limitations and errors in geophysical data acquisition;
iii) an understanding of geophysical data analysis and interpretation;
iv) knowledge of the principles of geophysical survey designs;
v) an understanding of the standards required for reporting and presentation to peers and the general public. The students will benefit from being exposed to problem solving and a workflow analogous to working for a major exploration or geophysical engineering company.

GEOPHYSICAL PROJECT (ENVS300)

Credits: 30 / Semester: whole session
A pinnacle of your degree, this module will embed you within an active research group where you will undertake an individual and unique geophysical research project over the course of an academic year. The results of your analyses may well constitute an original scientific finding forming part of a future peer-reviewed paper appearing in an international publication. In addition to developing specific and general research skills, you will gain invaluable experience in communicating your topic and findings in both an oral and written format.

**GEOPHYSICAL DATA MODELLING (ENVS386)**

**Credits: 15 / Semester: semester 1**

Geophysics talks are full of exciting colour figures showing the interior of the Earth. But are these pictures real? At best, they are only a simplified mathematical parameterisation of the true earth; at worst they can be misleading or plain wrong. This module provides the tools to construct such models by mathematical modelling of geophysical observations, but perhaps even more importantly, shows how such models can be interpreted, and provides understanding of their limitations. Mathematical foundations are given with sections on matrix analysis, optimisation theory and statistics, before going on to show how these are applied to geophysical problems. The concept of “non-uniqueness” is central—almost all geophysical modules require the estimation of an infinite (continuous) system from only finite data. Error estimation is considered in detail, in particular the reasons why most error estimates are close to worthless! Detailed examples are presented from all areas of geophysics, with a project to generate a model of the magnetic field of the planet Neptune. Examples also extend to modern developments, including links to “Big data” and Machine learning.

**OPTIONAL MODULES**

**APPLIED EARTHQUAKE AND VOLCANO SEISMOLOGY (ENVS388)**

**Credits: 15 / Semester: semester 2**

This module provides introduction to the fundamentals of applied seismology and essential training for students interested in academic or government careers in seismology. The course mainly deals with the analysis and interpretation of seismic data using arrays and networks of seismometers to constrain complex geological processes in tectonic and volcanic settings, and to evaluate earthquake and volcanic hazards. The course is research-led and provides a learning experience that reflects the process of creating knowledge through activities that mirrors modern research practices. Content will be delivered through a combination of traditional class-based lectures, research seminars and computer-based sessions. The students will have an opportunity to work with real-world seismic data, and will learn and apply state-of-the-art techniques used in operational settings for seismic and volcano monitoring.

**NUCLEAR AND PARTICLE PHYSICS (PHYS204)**

**Credits: 15 / Semester: semester 2**
Introduction to nuclear and particle physics

**OCEAN DYNAMICS (ENVS332)**

**Credits: 15 / Semester: semester 1**

Ocean dynamics addresses how the ocean and atmosphere circulate. Fundamental questions are addressed, such as how heat, salt, and dissolved substances are transported, how jets and weather systems emerge on our planet, why there are western boundary currents in the ocean, and how seafloor topography shapes the ocean circulation.

Students will improve their understanding of how the ocean and atmosphere behave, including comparing the importance of different physical processes in the climate system. The module is delivered via lectures and formative workshops to gain skills at problem solving. There is significant mathematical content, requiring familiarity with calculus and algebra. The module is assessed through two online tests (25% each) and an essay (50%).

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Programme details and modules listed are illustrative only and subject to change.

**HOW YOU’LL LEARN**

You will typically receive 15–20 hours of formal teaching each week, and complete between 50 and 100 days of residential fieldwork over the course of their programme. In years three and four you will carry out independent research projects on a topic and location of your choice. All projects are supervised by a member of staff who will meet with you on a weekly, or more frequent, basis.

A number of the School’s degree programmes involve laboratory and field work. The field work is carried out in various locations, ranging from inner city to coastal and mountainous
environments. We consider applications from prospective students with disabilities on the same basis as all other students, and reasonable adjustments will be considered to address barriers to access.

LIVERPOOL HALLMARKS

We have a distinctive approach to education, the Liverpool Curriculum Framework, which focuses on research-connected teaching, active learning, and authentic assessment to ensure our students graduate as digitally fluent and confident global citizens.
Careers and employability

The programme is particularly strong for careers in geophysical data analysis, and research areas related to global geophysics and planetary science.

89.5% OF ENVIRONMENTAL SCIENCES STUDENTS ARE IN WORK AND/OR FURTHER STUDY 15 MONTHS AFTER GRADUATION.

*Discover Uni, 2018-19.*

There has never been a better time to study Earth sciences. Many of the fundamental questions of our times will be answered by geoscientists, as we seek to provide sustainable resources for the world’s population, as well as predict and mitigate climate change and natural hazards by building a better understanding of the planet on which we live.

The majority of our recent graduates have gained employment within a degree-related field or continued within further education after graduation. We have close links with geoscience and environmental industries ensuring that our degrees properly equip you for future employment. The truly interdisciplinary nature of our degrees additionally makes graduates in Earth sciences highly sought after by other employment sectors.

RECENT EMPLOYERS

- Geological Surveys in the UK and abroad
- Hydrocarbon and support industries: ExxonMobil, BP, Shell, Geotrace, Geokinetics, Neftex, Robertson, Deloitte, CGG, Osiris, PGS

PREPARING YOU FOR FUTURE SUCCESS

At Liverpool, our goal is to support you to build your intellectual, social, and cultural capital so that you graduate as a socially-conscious global citizen who is prepared for future success. We achieve this by:

- Embedding employability within your curriculum, through the modules you take and the opportunities to gain real-world experience offered by many of our courses.
- Providing you with opportunities to gain experience and develop connections with people and organisations, including student and graduate employers as well as our global alumni.
- Providing you with the latest tools and skills to thrive in a competitive world,
including access to Handshake, a platform which allows you to create your personalised job shortlist and apply with ease.

- Supporting you through our peer-to-peer led Careers Studio, where our career coaches provide you with tailored advice and support.
Fees and funding
Your tuition fees, funding your studies, and other costs to consider.

TUITION FEES
Tuition fees cover the cost of your teaching and assessment, operating facilities such as libraries, IT equipment, and access to academic and personal support. Learn more about tuition fees, funding and student finance.

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<tr>
<th>UK fees</th>
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<tbody>
<tr>
<td>Full-time place, per year</td>
<td>£9,250</td>
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<tr>
<td>Year in industry fee</td>
<td>£1,850</td>
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<tr>
<td>Year abroad fee</td>
<td>£1,385</td>
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<th>International fees</th>
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<tr>
<td>Full-time place, per year</td>
<td>£24,100</td>
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Fees stated are for the 2022-23 academic year and may rise for 2023-24.

ADDITIONAL COSTS
We understand that budgeting for your time at university is important, and we want to make sure you understand any course-related costs that are not covered by your tuition fee. This includes costs for a lab coat, geological field kit, and sustenance during compulsory field trips.
Find out more about the additional study costs that may apply to this course.

SCHOLARSHIPS AND BURSARIES
We offer a range of scholarships and bursaries to help cover tuition fees and help with living expenses while at university.
Scholarships and bursaries you can apply for from the United Kingdom

Select your country or region for more scholarships and bursaries.
## Entry requirements

The qualifications and exam results you’ll need to apply for this course.

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<tr>
<th>Your qualification</th>
<th>Requirements</th>
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<tr>
<td><strong>A levels</strong></td>
<td>About our typical entry requirements</td>
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<tr>
<td></td>
<td>ABB</td>
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<td></td>
<td>Applicants with the Extended Project Qualification (EPQ) are eligible for a reduction in grade requirements. For this course, the offer is <strong>BBB</strong> with <strong>A</strong> in the EPQ.</td>
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<td>You may automatically qualify for reduced entry requirements through our contextual offers scheme.</td>
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<td></td>
<td>If you don’t meet the entry requirements, you may be able to complete a foundation year which would allow you to progress to this course.</td>
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<td>Available foundation years:</td>
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<td>- [Earth Sciences entry route leading to BSc (Hons) (4 year route including a Foundation Year at Carmel College)](Foundation Year at Carmel College)</td>
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<td></td>
<td>- [Physical Sciences entry route leading to BSc (Hons) (4 year route including a](Physical Sciences entry route leading to BSc (Hons) (4 year route including a)</td>
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<tr>
<td><strong>GCSE</strong></td>
<td>4/C in English and 4/C in Mathematics</td>
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<tr>
<td>Your qualification</td>
<td>Requirements</td>
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<td>Subject requirements</td>
<td>Mathematics and Physics A level. For applicants from England: Where a science has been taken at A level (Chemistry, Biology or Physics), a pass in the Science practical of each subject will be required.</td>
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<tr>
<td>BTEC Level 3 National Extended Diploma</td>
<td>D*DD in relevant Diploma, students will be invited to attend interview</td>
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<tr>
<td>International Baccalaureate</td>
<td>33 points with no score less than 4, inc. Higher Level Mathematics and Physics</td>
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<td>Irish Leaving Certificate</td>
<td>H1, H2, H2, H3, H3 including H2 or above in Mathematics and Physics</td>
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<td>Scottish Higher/Advanced Higher</td>
<td>Not accepted without Advanced Highers at ABB including Maths and Physics</td>
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<tr>
<td>Welsh Baccalaureate Advanced</td>
<td>Acceptable at grade B including Mathematics and Physics A Levels with grades AB</td>
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<tr>
<td>Access</td>
<td>Considered if taking a relevant subject. 45 Level 3 credits in graded units, including 30 at Distinction and a further 15 with at least Merit. 15 Distinctions are required in each of Mathematics and Physics. GCSE English and Mathematics grade C/4 or above also required. Students will be invited to attend interview.</td>
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<td>Your qualification</td>
<td>Requirements</td>
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<td><strong>About our typical entry requirements</strong></td>
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**International qualifications**

Many countries have a different education system to that of the UK, meaning your qualifications may not meet our entry requirements. Completing your Foundation Certificate, such as that offered by the [University of Liverpool International College](https://www.liverpool.ac.uk), means you’re guaranteed a place on your chosen course.

**ALTERNATIVE ENTRY REQUIREMENTS**

- If your qualification isn’t listed here, or you’re taking a combination of qualifications, [contact us](mailto:info@liverpool.ac.uk) for advice
- Applications from mature students are welcome.