Chemistry for Sustainable Energy MChem

COURSE DETAILS

- A level requirements: AAB
- UCAS code: F103
- Study mode: Full-time
- Length: 4 years

KEY DATES

- Apply by: 31 January 2024
- Starts: 23 September 2024

Course overview

Understanding the chemistry behind sustainable energy is central to creating the solutions to meet the world's future energy needs.

INTRODUCTION

This MChem programme is unique in the UK and demonstrates the breadth and depth of research being carried out to address issues of sustainability and global energy demand.

The programme will give you a foundation of knowledge in areas of energy conversion, that show the most promise of achieving sustainability at this point, including:

- Fuel cells
- Solar photovoltaics
- Biomass and biology energy conversion processes
- Green chemistry synthetic routes.

In addition, energy storage options through battery and supercapacitor technology will be critically examined. The programme offers you a broad understanding of relevant fundamental chemical principles and in-depth exposure to the development of new and creative approaches to sustainable energy development.

Understanding the chemistry of the energy sector and having the skills and knowledge to change and develop systems away from fossil fuels to green energy, is a growing necessity. Sustainable energy is a critically important area of chemistry and we need to significantly increase the number of people skilled to tackle the multitude of challenges facing our planet.

Throughout this programme you will be taught by leaders and innovators active within sustainable energy research and will have the opportunity to link in with the outstanding work being progressed by the University of Liverpool's world renowned Stephenson Institute for Renewable Energy.

WHAT YOU'LL LEARN

- Explore energy conversion options using fuel cells, solar photovoltaics, biomass and biology energy conversion and green chemistry synthetic routes
- Examine energy storage options through battery and supercapacitor technology
- Gain a broad understanding of fundamental chemical principles

ACCREDITATION

Our MChem programmes have bachelor accreditation from the Royal Society of Chemistry (RSC) ensuring your degree with us will set you on the pathway to a successful career.

Course content

Discover what you'll learn, what you'll study, and how you'll be taught and assessed.

YEAR ONE

In the first year, you will take modules that cover the fundamentals of Inorganic, Organic and Physical Chemistry, plus necessary key skills. Four Chemistry modules combine theoretical and practical aspects and one Chemistry module develops Quantitative and General Key Skills.

You will spend three to six hours per week in the laboratory and so will receive a comprehensive training in practical aspects of the subject.

In addition, you will have a choice of subsidiary modules from other Departments including Environmental Sciences, Biological or Biomedical Sciences (Anatomy, Molecular Biology, Biochemistry, Pharmacology or Physiology), Mathematics, Physics and Archaeology.

There are also optional courses within Chemistry covering, eg the Chemistry-Biology interface, and in the second semester you can opt to take a research inspired course 'Innovative Chemistry for Energy and Materials' delivered by staff in the Stephenson Institute for Renewable Energy.

COMPULSORY MODULES

INNOVATIVE CHEMISTRY FOR ENERGY AND MATERIALS (CHEM184)

Credits: 15 / Semester: semester 2

The module covers a wide variety of topics in the area of innovative chemistry for energy and materials. This will act as an introduction to these areas to enable the student to pursue their interests to a deeper level independently, and to provide a foundation level knowledge in materials and electrochemistry, to be expanded in subsequent core and optional chemistry modules.

INTRODUCTORY INORGANIC CHEMISTRY (CHEM111)

Credits: 15 / Semester: semester 1

This module gives an introduction to the chemistry of the main group elements, using the periodic table as the underpinning framework for understanding this chemistry, and develops students' analytical chemistry skills including volumetric and spectrophotometric techniques applied to materials that are familiar in everyday life.

INTRODUCTORY ORGANIC CHEMISTRY (CHEM130)

Credits: 30 / Semester: whole session

An Introduction to Organic Chemistry consisting of lectures, workshops and laboratory classes assessed continuously and by four class tests

INTRODUCTORY PHYSICAL CHEMISTRY (CHEM152)

Credits: 15 / Semester: semester 2

This module builds on the thermodynamics and kinetics that students have studied prior to University. Learning is supported by both problem-solving workshops and undertaking experiments in the laboratory

INTRODUCTORY SPECTROSCOPY (CHEM170)

Credits: 15 / Semester: whole session

This module will provide an introduction to a variety of spectroscopic techniques. Students will explore the theory underpinning various spectroscopic methods, how they are put into practice when acquiring spectra, and the interpretation of spectra to identify unknown substances.

KEY SKILLS FOR CHEMISTS 1 (CHEM180)

Credits: 15 / Semester: whole session

The aim of this module is: (i) to equip students with the basic quantitative transferable skills required for the first year of a Chemistry degree programme. (ii) to broaden a student's perspective of chemistry whilst developing their general transferable skills focusing on communication and employability. The overarching learning outcome is for students to have the key skills that will equip them to perform well in the rest of their chemistry degree programme.
Quantitative Key Skills will be taught using a lecture/workshop format involving problem solving classes, using computers where necessary. General Key Skills will involve a series of lecture-based presentations given by staff from the Department of Chemistry and the Careers Service together with a database workshop and small group tutorials. Extensive use of online platforms will be made.

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

YEAR TWO

COMPULSORY MODULES

CHEMISTRY FOR SUSTAINABLE TECHNOLOGIES (CHEM284)

Credits: 7.5 / Semester: semester 2

This module introduces the basic concepts of sustainability and sustainable development, particularly in relation to their technological underpinnings. The module will address the role of chemistry in relation to broad societal, environmental and developmental questions. The module also gives a fundamental understanding of the principles and technologies in Green Chemistry and the generation of Renewable Energy and Chemicals.

COORDINATION AND ORGANOMETALLIC CHEMISTRY OF THE D-BLOCK METALS (CHEM214)

Credits: 15 / Semester: semester 2

The module introduces the descriptive coordination and organometallic chemistry and the concepts underpinning our understanding of this chemistry.

FUNCTIONAL ORGANIC MATERIALS (CHEM241)

Credits: 15 / Semester: semester 1

Organic functional materials are of increasing global importance with applications in energy, medicine and electronics. This module will highlight how functional organic materials such as high-performance polymers, crosslinked polymers and composites, and porous materials can be designed for specific applications. The module will also explain how advanced characterisation methods (including scattering techniques, gas sorption, size exclusion chromatography, thermogravimetric analysis, tensile measurement, and electron microscopy) are used in the development of modern materials. Additionally, this module will provide an introduction to polymers, outlining aspects of polymer synthesis, properties and characterisation. Some of the history, importance, and current issues of polymeric materials – such as sustainability – will be discussed to provide an understanding of the wider context. CHEM241 will be useful to chemists who wish to develop a deeper understanding of how organic compounds can be designed to provide functional materials

INORGANIC APPLICATIONS OF GROUP THEORY (CHEM316)

Credits: 7.5 / Semester: semester 2

This module shows how an understanding of the symmetry properties of molecules can be applied to the understanding of spectroscopic selection rules and bonding.

MEASUREMENTS IN CHEMISTRY (CHEM246)

Credits: 15 / Semester: semester 2

This is a practical module in which students learn the practice of taking physical measurements, the critical analysis and evaluation of experimental data, the application of measurements to the study of chemical phenomena and the dissemination of results.

ORGANIC CHEMISTRY II (CHEM231)

Credits: 15 / Semester: semester 1

This module is the core Organic Chemistry module for Year 2 Chemistry students. It introduces important carbon-carbon bond forming reactions within a mechanistic and synthetic framework, together with exposure to a selection of stereochemical issues.

PHYSICAL CHEMISTRY II (CHEM260)

Credits: 15 / Semester: whole session

This module expands on the fundamentals of Physical Chemistry that were introduced in Year 1. The principles and applications of thermodynamics, kinetics and spectroscopy are covered in detail with more emphasis on derivation of key results than in Year 1. Quantum mechanics is developed from the basic principles and mathematical description of quantum phenomena. It is applied to describe bonding in small molecules and in solids, and is linked to spectroscopy via detailed description of molecular energy levels and the possible transitions between these permitted by quantum mechanics.

PREPARATIVE CHEMISTRY: SYNTHESIS AND CHARACTERISATION (CHEM245)

Credits: 15 / Semester: semester 1

The module presents a unified approach to the synthesis and characterisation of organic and inorganic compounds, introducing a range of synthetic techniques, experiments and analytical methods.

KEY SKILLS FOR CHEMISTS 2 (CHEM280)

Credits: 15 / Semester: whole session

This module aims to (i) further develop the quantitative skills of a student, (ii) introduce students to the Chemistry Key Skill of Molecular Modelling, and (iii) maintain student development of general transferable and employability skills. The overarching learning outcome is that students will gain the necessary key skills to perform well in their chemistry degree programmes. By the end of the module students will have improved their ability to perform and apply mathematical techniques to problems in kinetics, thermodynamics, quantum mechanics and molecular symmetry. They will have developed abilities to employ force-field and Quantum Chemistry techniques in Molecular Modelling using the Spartan package. They will also have further developed their range of transferable and employability skills, including written and oral communication and team working.

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

YEAR THREE

COMPULSORY MODULES

BIOLOGICAL ENERGY CONVERSION PROCESSES (CHEM382)

Credits: 7.5 / Semester: semester 2

This module will focus on energy conversion processes found in nature. Energy as a commodity is described as "reducing power" or as "high energy electrons" and the concept of nutrient or fuel is introduced. Biological energy conversion processes are discussed from an evolutionary perspective, and it is described how they have contributed to the current composition of the planet's atmosphere and crust. Sustainability issues will become apparent when comparing the time scales of biogenic fuel accumulation and human consumption of fuel.

BIORENEWABLE CHEMICALS FROM BIOMASS (CHEM384)

Credits: 7.5 / Semester: semester 2

This module provides the scientific and technical foundation to understand the utilisation of biomass, the emerging renewable chemicals industry, biorefinaries and the implications that these technologies will have.

CATALYSIS (CHEM368)

Credits: 15 / Semester: semester 2

This module will give students a broad, interdisciplinary, background in catalysis across the traditional divides within chemistry.

FURTHER ORGANIC CHEMISTRY (CHEM333)

Credits: 15 / Semester: semester 1

An extension of second year organic chemistry, covering pericyclic reactions, rearrangements and fragmentations, radical reactions, uses of phosphorous, sulphur and selenium in synthetic chemistry, as well as some core physical-organic concepts.

INORGANIC MATERIALS CHEMISTRY (CHEM313)

Credits: 15 / Semester: semester 1

This module builds on the fundamental inorganic chemistry that students have studied previously to give an appreciation of the science underpinning the development of modern materials. It will discuss the fundamentals of crystalline and disordered solids, and magnetism; methods for synthesising materials; characterisation techniques; applications of inorganic materials; and the link between the chemistry, structure and function of materials.

PRACTICAL CHEMISTRY YR 3 (MCHEM) (CHEM375)

Credits: 22.5 / Semester: semester 1

In this module, students will carry out a bespoke collection of advanced experiments in three of the areas of Organic, Inorganic, Physical or Computational Chemistry

PRACTICAL CHEMISTRY PROJECT YEAR 3 - AN INTRODUCTION TO RESEARCH METHODS (CHEM366)

Credits: 15 / Semester: semester 2

This module is taken by year 3 MChem students in the 2nd semester. Students will be assigned mini research projects based on their project preference and potential projects offered by academic staff. Students carry out these projects in research labs for 9 weeks.

KEY SKILLS FOR CHEMISTS 3 (CHEM385)

Credits: 7.5 / Semester: semester 1

This module aims to help Chemistry students develop skills needed for further educational opportunities (i.e. MSc/PhD) or employment in a wide range of chemical and non-chemical based sectors. During the 'Employability skills' section, students will look at a variety of employability related skills, job application exercises, interview preparation techniques and presentation experience. This will be in the form of asynchronous lectures, online and in-person workshops and in-person tutorials and will require reflective thinking and group work – this will be facilitated by the module staff and other colleagues from the institution and wider industry. During the 'database' section, students will further their knowledge of the scientific literature developed during years 1/2 by engaging with more advanced aspects of various databases and writing a scientific electronic report of an experiment the students have completed in the laboratory.

FURTHER PHYSICAL CHEMISTRY (MCHEM) (CHEM354)

Credits: 15 / Semester: semester 2

The aim of this module is to extend a student's knowledge of Physical Chemistry, in particular to demonstrate the relationship between microscopic and macroscopic models for physical chemical phenomena, the quantum mechanical description of chemical bonding and the physical chemistry of electrochemical cells, surfactants and colloids.

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

YEAR FOUR

COMPULSORY MODULES

CHEM480 - CHEMICAL RESEARCH PROJECT (CHEM480)

Credits: 60 / Semester: whole session

The aim of this module is to develop the skills necessary to undertake independent chemical research. Students carry out a research project of their choice in an area that is presently active in the department and that is aligned with our research clusters in Energy and Catalysis, Materials Chemistry, Medicinal and Bio-Nano Chemistry, Functional Interfaces, Theoretical and Computational Chemistry. This is delivered by becoming a member of a research group led by academic staff of the Department of Chemistry and by carrying out experimental or theoretical/computational work as a member of that research group. In addition, the student's skills in molecular modelling techniques in chemistry and chemical database skills are further developed and the student's employability awareness and skills will be enhanced.

ELECTROCHEMISTRY (C OPTION) (CHEM453)

Credits: 7.5 / Semester: semester 1

The aim of this module is to develop the students' knowledge of interfacial electrochemistry. This includes both the understanding of fundamental aspects of electrochemistry, as well as techniques for characterising surfaces under electrochemical conditions. Applications of electrochemistry will also be discussed.

OPTIONAL MODULES

ADVANCED SPECTROSCOPY (C OPTION) (CHEM451)

Credits: 7.5 / Semester: semester 1

This is an advanced module that introduces the student to modern spectroscopic techniques and their applications in materials characterisation. Emphasis is given to those techniques, which are currently most important to chemical research both in industry and academia. At the end of the module, students should be able to understand the basic physical principles of these techniques and be able to decide which combination of techniques is best employed to tackle a particular problem of materials characterisation.

APPLICATION OF ENZYMES IN ORGANIC SYNTHESIS - INDUSTRIAL BIOTECHNOLOGY (CHEM486)

Credits: 7.5 / Semester: semester 2

The aim of this module is to provide students with a knowledge and understanding of the application of enzymes in organic synthesis with a focus on selectivity and sustainability. Selected industrial examples will illustrate where biocatalysis can replace or be combined with conventional chemical reactions in drug synthesis. The module will include an introduction to molecular biology, exciting new developments in the field such as directed evolution for the creation of designer enzymes, creation of artificial enzymes by combining chemo-and biocatalysis and development of synthetic pathways using enzymes. Industrial biotechnology is an important area for a sustainable future and this module will provide a solid foundation from a chemistry perspective.

ASYMMETRIC CATALYSIS FOR ORGANIC AND PHARMACEUTICAL CHEMISTRY (CHEM496)

Credits: 7.5 / Semester: semester 2

The aim of the module is to introduce students to the main aspects of asymmetric catalysis and its application in synthetic organic chemistry.

ASYMMETRIC SYNTHESIS AND SYNTHETIC STRATEGY (CHEM433)

Credits: 7.5 / Semester: semester 1

This module will develop and extend the students' knowledge of modern organic chemistry, so that they will be able to enter directly into a PhD programme or embark on a career as a specialist chemist.

INTRODUCTION TO NANOMEDICINE (CHEM426)

Credits: 7.5 / Semester: semester 2

Nanomedicine is an increasingly important multidisciplinary, global science. This is an introductory module which aims to provide students with the essential knowledge required to understand the rapidly advancing field of Nanomedicine. Following some introductory lectures, students will undertake self-directed learning alongside
lectures to examine leading published research related to the design of advanced nanomedicines and clinical trials.
This module will be useful chemists who wish to develop a deeper understanding of colloid materials, gain a detailed insight into the advanced synthetic approaches used to produce nanomedicines and broaden their knowledge of pharmacology concepts.

MAIN GROUP ORGANIC CHEMISTRY (CHEM431)

Credits: 7.5 / Semester: semester 1

The aim of this module is to broaden and extend the knowledge of modern Organic Chemistry, so that students will be able to enter directly into a PhD program or embark on a career as a specialist chemist. By the end of the module students will have achieved a solid foundation in Organic Chemistry.

ORGANIC AND MOLECULAR ELECTRONICS (CHEM413)

Credits: 7.5 / Semester: semester 1

This module is designed to give students in the chemical sciences an appreciation of the foundations and working principles underlying the new technologies of organic electronic devices, and of the possibilities offered by the new science of single-molecule electrical measurements.

PROTEIN STRUCTURE AND DYNAMICS (CHEM452)

Credits: 7.5 / Semester: semester 2

This module discusses the application of basic physical chemistry concepts for describing protein structure and dynamics and shows how advanced physical chemistry methods are used for investigating these important aspects of proteins.

SUPRAMOLECULAR CHEMISTRY (CHEM446)

Credits: 7.5 / Semester: semester 2

Supramolecular chemistry – or, "chemistry beyond the molecule" – covers a wide range of systems including host-guest systems, clathrates, cavitands, supramolecular polymers and gels, and makes use of non-covalent interactions. These weak and reversible forces—such as hydrogen bonds, hydrophobic forces, van der Waals forces, and metal–ligand coordination—are key to understanding biological processes and self-assembling systems, and to constructing complex materials and molecular machinery. This module is an introduction to this truly interdisciplinary and evolving field.
In this module, the students will be introduced to concepts such as molecular self-assembly, host-guest complexes and biological mimics. The course will also cover the latest developments in supramolecular chemistry, and highlight some of the key challenges in the field being addressed by researchers at Liverpool and beyond.

APPLIED ORGANIC CHEMISTRY: BIOSYNTHESIS AND INDUSTRIAL SYNTHESIS OF NATURAL PRODUCTS (CHEM436)

Credits: 7.5 / Semester: semester 2

This module focuses on the utility of organic chemistry for the industrial synthesis of a range of important natural products used in medicine, agriculture, food and perfume industry and domestic sector. It will help students to put a general knowledge of different classes of organic compounds and their reactivity into the context of real-world applications. The module will also highlight the history of discovery of some notable natural products and will demonstrate how rather obscure original findings were translated into successful industrial processes using recent developments in organic synthesis and catalysis.

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (CHEM471)

Credits: 7.5 / Semester: semester 1

This is an advanced module that aims to introduce the student to modern nuclear magnetic resonance (NMR) spectroscopic techniques and their applications in analytical chemistry. The students will be able to understand the basic physical principles of NMR and to decide how to use it to tackle a particular problem of molecules and materials characterisation.

SOLID STATE CHEMISTRY AND ENERGY STORAGE MATERIALS (CHEM442)

Credits: 7.5 / Semester: semester 2

The course will build upon foundations of descriptive aspects of solid state chemistry delivered in Year 1 (CHEM111) and more advanced topics delivered in Year 3 (CHEM313) to address a wide variety of research-led topics in the area of solid state chemistry synthesis and characterisation, with a focus on some of the relevant applications in energy materials. This will provide the student with a deep and high level understanding of the properties of solids, and currently active areas of research, to enable the student to pursue their interests to a deeper level independently (for example to PhD level).

SOLAR ENERGY CONVERSION (CHEM464)

Credits: 7.5 / Semester: semester 2

In part 1 the course covers the underpinning theory of electronic structure of solids relevant to solar energy conversion materials. In part 2 the course examines a range of established and developing solar energy conversion technologies using the concepts developed in part 1. The course revises and builds on the contents of core inorganic and physical chemistry modules from years 2 and 3.

NANO ENERGY MATERIALS (CHEM482)

Credits: 7.5 / Semester: semester 2

The module will deal with nanoscale energy materials focusing on the aspects relevant to catalysis, electrocatalysis, plasmonic heating, batteries and thermal energy storage. Particular emphasis will be placed on the reasons why nanomaterials are desirable for energy storage applications.
The goals of the module are (i) to introduce nanomaterials for energy storage; (ii) to introduce nanocarbons for thermal energy storage; (iii) to describe general methods for synthesis of nanomaterials.

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

HOW YOU'LL LEARN

Laboratory classes in Years One and Two prepare you for independent laboratory work in Years Three and Four. In Year Three you will carry out mini research projects, while in Year Four you will carry out research alongside PhD and postdoctoral researchers on cutting edge projects, often leading to a first scientific publication. Computational modelling and molecular visualisation are introduced as interactive animated models from Year One, reinforced as a key skill in later years and by Year Four of MChem programmes you will be able to perform your own calculations to underpin final year research projects.

HOW YOU'RE ASSESSED

You are assessed by examination at the end of each semester (January and May/June) and by continuous assessment of laboratory practicals, class tests, workshops, tutorials and assignments. You have to pass each year of study before you are allowed to progress to the following year. Re-sit opportunities are available in September at the end of Years One and Two. If you take an industrial placement, a minimum standard of academic performance is required before you are allowed to embark on your placements. You are expected to perform at a 2:1 level if you wish to continue on a MChem programme. All years of study (with the exception of Year One) contribute to the final degree classification.

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

Our graduates develop a wide range of skills including numeracy, problem-solving and IT in addition to scientific skills. Visits to the Department by leading companies such as GlaxoSmithKline and Unilever ensure that you make contact with prospective employers at key stages in your final year.

Typical careers of our graduates include

- assistant analyst
- development chemist
- research assistant
- site chemist.

Recent employers:

- GlaxoSmithKline
- Unilever
- IOTA Nanosolutions Ltd
- Perstorp Caprolactones
- Shell
- Towers Watson
- United Utilities.

4 IN 5 **CHEMISTRY STUDENTS FIND THEIR MAIN ACTIVITY AFTER GRADUATION MEANINGFUL.**

Graduate Outcomes, 2018-19.

Fees and funding

Your tuition fee covers almost everything, but you may have additional study costs to consider, such as books, specialist equipment or field trips.

TUITION FEES

UK fees (applies to Channel Islands, Isle of Man and Republic of Ireland)	
Full-time place, per year	£9,250

International fees	
Full-time place, per year	£27,200

Fees are correct for the academic year 2024/25

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.

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 could include buying a laptop, books, or stationery.

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 provide tuition fee discounts and help with living expenses while at university.

Check out our Undergraduate Global Advancement Scholarship. This offers a tuition fee discount of up to £5,000 for eligible students starting an undergraduate degree from September 2024. There's also the Liverpool Bursary which is worth £2,000 per year for eligible students.

[Discover our full range of undergraduate scholarships and bursaries]

Entry requirements

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

Your qualification	**Requirements** About our typical entry requirements
A levels	AAB Applicants with the Extended Project Qualification (EPQ) are eligible for a reduction in grade requirements. For this course, the offer is **ABB** with **A** in the EPQ. You may automatically qualify for reduced entry requirements through our contextual offers scheme.
GCSE	4/C in English and 4/C in Mathematics
Subject requirements	For applicants from England: Where a science has been taken at A level (Chemistry, Biology, Geology or Physics), a pass in the Science practical of each subject will be required.
BTEC Level 3 National Extended Diploma	Not accepted – applicants should apply for F100.
International Baccalaureate	35 points including 6 points from Chemistry at higher level and 5 points from one other science at higher level.
Irish Leaving Certificate	H1, H1, H2, H2, H2, H3 (including Chemistry and one other Science)
Scottish Higher/Advanced Higher	Not accepted without Advanced Highers

Your qualification	Requirements About our typical entry requirements
Welsh Baccalaureate Advanced	Accepted at grade B, including 2 science A levels at grades AA including Chemistry.
Access	Not accepted – applicants should apply for F100.
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, 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 for advice
- Applications from mature students are welcome.

THE ORIGINAL REDBRICK