AS:MIT
MSc in Analytical Science
Analytical Science: Methods and Instrumental Techniques
Warwick Centre for Analytical Science

An EPSRC approved masters training package at the University of Warwick

www2.warwick.ac.uk/fac/sci/chemistry/chemintra/postgrad/taughtmasters/mscinfo/
INVESTMENT
Following a Science and Innovation Award to establish the UK’s only EPSRC funded Warwick Centre for Analytical Science (http://www2.warwick.ac.uk/fac/sci/wcas/) and the designation of ‘Science City’ status to the Birmingham region (www.birminghamsciencecity.co.uk), there has been significant recent investment in people, state of the art equipment and instrumentation for analytical science at Warwick. The Masters Course in Analytical Science: Methods and Instrumental Techniques (AS:MIT) benefits directly from this investment, by drawing on the unique instrumental facilities and expertise available.

INTERNATIONALLY LEADING
The course is delivered by internationally leading experts from the Departments of Chemistry, Physics, Statistics, Engineering, and the Life Sciences at Warwick, as well as visiting lecturers from companies such as Syngenta and Astra-Zeneca. Students gain hands-on practical experience with a range of equipment relevant to each module, enabling graduates from the course to work in any modern laboratory since the skills they will acquire are readily transferable between sub-disciplines.

RELEVANT
Analytical Science is central to Chemistry and many other sciences, and fundamental to many key industries. Advances in Analytical Science underpin research and development in Materials, Environmental, Biological, Biomedical, and Pharmaceutical Sciences. Clearly, any industrialised or developing country has a great need for skilled analytical scientists.

SHOULD I APPLY?
The course is targeted at students who will go on to work in areas such as the life sciences (including pharmaceutical and environmental science), and materials science, and we invite applications from students with backgrounds in Chemistry, Physics, Biology, Statistics and Maths. AS:MIT will equip students with a comprehensive understanding of analytical techniques and excellent practical skills. The MSc qualification provides an excellent foundation for a career in industry and further research at PhD level.
**AS:MIT MSc**

**Module list**

**CORE**  
Statistics for Data Analysis  
Principles and Techniques in Qualitative and Quantitative Analysis  
Techniques for the Characterisation of Biomolecules  
Microscopy and Imaging  
Team Research Project: Real World Analysis  
Warwick Interdisciplinary Science Transferable Skills Module

**OPTIONS**  
Electrochemistry and Sensors  
Magnetic Resonance  
Mass Spectrometry  
Chromatography and Separation Science  
Advanced Statistics and Chemometrics  
Advanced Electron Microscopy – Theory and Practice

**MSc Research Project**

Projects are proposed by members of staff from the Chemistry, Physics, Statistics, Life Sciences and Engineering Departments.

Projects cover a wide range of topics, from instrument and technique development to application of analytical methods and procedures. The projects are carried out either at Warwick or at a company sponsoring.

“Stimulating, research-led education linking academia and industry.”

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**AS:MIT Profiles**

'‘I joined the MSc course after a career in teaching because I wanted to broaden my knowledge of chemistry. The modular structure of the programme was an effective way of covering a range of analytical methods in a short time and I really enjoyed the variety of content from modern spectroscopic techniques to traditional "wet chemistry". The course gave me a thorough theoretical understanding of instrumental techniques, which was put into practice during the laboratory sessions, and enabled me to work as an analytical chemist after completing the MSc. The research project was an opportunity to specialise in an area of interest and the experience prepared me well for subsequent study at PhD level.’

Sue Cannan  
Senior lecturer in Science Education  
University of Bedfordshire
We welcome the opportunity for students or employees to study one or two modules on a short term basis.

Those who already work in industry or any other analytical laboratory field will find the course a valuable means of updating their expertise.

Please contact the Course Coordinator for enrolment procedures.

AS:MIT Profiles

“This module is ideal for anyone who has a working knowledge of chromatography either on an academic or commercial level and wants to improve their understanding of the subject through interesting and informative lectures and laboratory practicals that are carried out in Warwick’s excellent laboratory facilities.”

Ruth Britton
Laboratory Technician
University of Lincoln-Holbeach on the Chromatography & Separation Science Module

AS:MIT MSc

Module descriptions

Our modules cover a wide range of techniques and instrumentation. Along with input from the academic staff, many of our modules also benefit from industrial input.

STATISTICS FOR DATA ANALYSIS
The aim of this module is to give students a basic understanding of the statistical methods appropriate to data analysis in analytical science, and to provide guidance on some statistical tools for more advanced study. Topics include: basic probability; error analysis and calibration; summarising data and testing simple hypotheses; statistical computing (software and practice, including simple graphics); experimental design and analysis of variance; sampling methods and quality control; simple analysis of multivariate data. Each session will combine lecture and data analysis workshop. At the end of the course the student should be able to appreciate the added value that statistical analysis can bring to research to perform basic statistical analyses of simple data sets using statistical software to design simple experiments.

PRINCIPLES AND TECHNIQUES IN QUANTITATIVE AND QUALITATIVE ANALYSIS
This module covers theoretical and practical fundamentals of qualitative and quantitative analysis. We will discuss sources of errors in chemical and instrumental analysis, and will consider practical aspects of sampling and calibration techniques. Theory and instrumentation of a range of spectroscopic techniques will be covered in lectures. Practical sessions will include quantitative analyses using volumetry, gravimetry, uv/visible spectroscopy, atomic absorption spectroscopy, and state-of-the-art inductively coupled plasma spectroscopy (ICP) techniques (OES and MS).

TECHNIQUES FOR THE CHARACTERIZATION OF BIOMOLECULES
This module introduces students to biophysical instrumentation, methods of data collection and analysis. Issues of data quality will be addressed and students will be equipped with data sets for use in later modules. It provides an introduction to absorbance, fluorescence, X-ray crystallography, mass spectrometry, NMR, circular and linear dichroism.

MICROSCOPY AND IMAGING
This module provides a foundation in the principles and applications of microscopy, starting with basics of light microscopy and progressing to state of the art confocal microscopy, electron microscopy and scanned probe microscopy. The latter includes atomic force microscopy and electrochemical imaging techniques for which Warwick is particularly well-known. The module includes workshops on image analysis and seminars that cover the most recent developments in the field.

TEAM RESEARCH PROJECT: REAL WORLD ANALYSIS
Research questions in academia and industry generally require the development and integration of several analytical techniques. The aim of this module is to make students aware of these requirements. It is the culmination of the taught part of the course, and constitutes the ideal preparation for the research project and future careers in analytical laboratories. The practical work for this module involves team work to solve real analytical problems using at least two techniques and professional data analysis. Literature work will be required as the basis of method development. Research work is complemented by interactive sessions with industrial visitors.
**AS:MIT MSc**

**Module descriptions**

**ELECTROCHEMISTRY AND SENSORS**  
This module provides a grounding in the fundamentals of electrochemistry, electroanalytical techniques and sensor technology. The module encompasses potentiometric methods, voltammetric/amperometric techniques, microfluidic devices, lab-on-a-chip methods, and electronic noses and tongues. Electrochemistry aspects draw on Warwick’s major strengths in this area and include developments in ion selective electrodes, electrode kinetics and mass transport and key techniques, such as linear sweep and cyclic voltammetry, hydrodynamic electrodes, stripping voltammetry, ultramicroelectrodes and array devices. Lectures and problems classes are supplemented by laboratory sessions which provide students with practical hands-on experience.

**MAGNETIC RESONANCE**  
Nuclear magnetic resonance (NMR) in both solution and the solid state as well as electron paramagnetic resonance (EPR) will be described. The course will cover the underlying theory of the experiments as well as practical aspects of recording spectra and their interpretation. The importance of magnetic resonance across science, in, e.g., organic chemistry, pharmaceuticals and proteins, will be demonstrated.

**MASS SPECTROMETRY**  
This module introduces the student to the many facets of modern mass spectrometry. Emphasis is placed both on the interpretation of spectra and also on instrumental methods, covering modern methods of ionisation (including ESI and MALDI) and mass analysis (including orthogonal TOF and FT-ICR) and the use of linked methods such as GC/MS, HPLC/MS and tandem mass spectrometry. Practical sessions include practice at interpretation and experiments using various mass spectrometric techniques.

**CHROMATOGRAPHY AND SEPARATION SCIENCE**  
During this interdisciplinary module students will learn about theory and practice of different types of chromatography and their application in real-world scenarios. They will develop the skills necessary to decide how to decide which methods are the most appropriate for a given separation problem - whether for analysis or purification of, for example, synthetic polymers, biomolecules or biopharmaceuticals.

**ADVANCED STATISTICS AND CHEMOMETRICS**  
This module provides theoretical background and a comprehensive practical toolbox for extracting information from experimental data, with particular focus on the full complexity of modern analytical science techniques. We will examine how appropriate explicit mathematical descriptions of processes underlying analytical data acquisition, based on sound physics and chemistry, can be incorporated in statistical models. Core theoretical components of this module are univariate and multivariate distribution theory and principles of statistical inference. Practical components of the module include the implementation of selected models using standard computer languages (e.g. Matlab, R) and the analysis of benchmark experimental datasets.

**ADVANCED ELECTRON MICROSCOPY – THEORY AND PRACTICE**  
This module aims to give a good general grounding in the theory and practice of modern electron microscopy and associated techniques. Module topics include electron diffraction; the Transmission Electron Microscope (TEM); The Scanning Electron Microscope (SEM); Chemical Analysis in the Electron Microscope (X-ray Microanalysis; EELS; Introduction to Scanning Transmission electron microscopy (STEM)); Image and diffraction simulation; Recent Advances in instrumentation (aberration correction and monochromation); Specialised imaging techniques (electron tomography and holography); Complementary imaging techniques.

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**AS:MIT Profiles**

"I studied as an undergraduate in the Department of Chemistry at the University of Warwick so I already knew that the quality of teaching was of a high standard. The MSc course was ideally suited to me as it honed my practical skills and knowledge of analytical chemistry. I feel I got the most out of the course because the first six months were modular, taught in small groups and were accompanied by a wide variety of practical experiments. This set me up well for the research project that followed, which was based in one of the mass spectrometry laboratories. The project involved working closely with postdoctoral researchers and academics on a challenging project. Looking back, it also provided a very good taster of what PhD research would entail and taught me skills that I use day-to-day in my career."

Nafeesa Dajda  
University Relations Manager  
Research in Motion UK Limited

www2.warwick.ac.uk/fac/sci/chemistry/chemintra/postgrad/taughtmasters/mscinfo/
Life at Warwick

The University of Warwick is a leading UK institution which is internationally acclaimed for research in science and engineering, and as an innovator in knowledge transfer to industry and the community. Students and researchers on campus are from more than 120 nations, making for a thriving multi-cultural environment. The University has an active International Office to help with the orientation of students from overseas.

The Warwick Centre for Analytical Science (WCAS) provides a hub for the widest range of analytical and measurement science with active involvement from Chemistry, Physics, Statistics, Life Sciences, the Medical School and other Warwick Departments. As an AS:MIT student you will benefit from being at the heart of this hub which provides an environment for the flow of ideas between different areas and opportunities for collaborative working.

The University of Warwick boasts the largest arts centre on any campus outside of London and has recently undergone a new multi-million pound extension and refurbishment to the concert hall. The Arts Centre also has two theatres, a cinema and an art gallery and Warwick regularly plays host to stars from contemporary, popular and classical genres of music, as well as top-named comedians.

The Student Union has also recently undergone a rebuild to the tune of £11 million, offering Warwick students a purpose built facility with a wide range of entertainment including bars, dance venues, food outlets, student representation at all levels, and societies and sports clubs that cater for every interest. The Campus also provides for your everyday needs including health care, shops, banks, a post office, laundrettes, hairdressers and a travel agent.

Sporting life is great at Warwick whatever your preference. There are excellent facilities including a swimming pool, gym, squash courts and playing fields. This accompanies many sporting activities and events held throughout the year and supported by the enthusiasm and encouragement from our dedicated sports staff.

Warwick University has a great location in the heart of England and is easy to reach from all parts of the UK and abroad by train, car or air. The bustling city of Coventry is about 15 minutes away, whilst there are several other good places within easy reach: Birmingham, UK’s second city and the historic towns of Kenilworth, Warwick, Stratford and Leamington Spa, whilst a trip to London will take just over 1 hour by train from Coventry Station.

The MSc provided me with a firm foundation upon which I am still continuously building upon. AS:MIT was valuable career preparation; relevant to both industrial and academic related posts. I have gained vital hands on experience and skills in a range of analytical techniques routinely used in a variety of scientific fields. Furthermore, I had the unique opportunity to observe and apply analytical chemistry in several ‘real world’ situations. The modular balance between theory and practical enables a good useful working knowledge to be obtained. The wide selection of independent research projects allowed me to develop my understanding in my own areas of interest and acquire specialist instrumental expertise which I utilise daily. The entire course was an excellent chance to have a ‘taster’ and to find my own particular niche. In summary, the more you put in the more you will get out.”

Rajan Randev
PhD Student
University of Warwick
Facilities

AS:MIT taught sessions take place in two primary locations: within the Department of Chemistry; and in the MOAC Doctoral Training Centre (http://www2.warwick.ac.uk/fac/sci/moac/). Selected sessions may take place in other Science departments.

Learning at Warwick is supported by an excellent Library as well as the Learning Grid (http://www2.warwick.ac.uk/services/library/grid/), which offers wireless access points, networked PCs, and many other resources.

Under the umbrella of the Centres for Analytical Science and Advanced Materials, Warwick Science is home to an extraordinary array of facilities to carry out world-class research and to provide training at the highest level. It is the home of the world-leading Magnetic Resonance Centre, which houses thirteen superconducting magnets for NMR, including the UK’s only wide-bore solid-state 850 MHz NMR spectrometer, a 700 MHz solution-state NMR spectrometer with cryo-probe, and a three-magnet solid-state DNP system. Five further magnets (250 MHz-500 MHz) are housed in the Chemistry Department.

Outstanding instrumentation is available in the area of microscopy, including Scanning and Transmission Electron Microscopes, Atomic Force Microscopes, and Confocal Microscopes. A high-end X-ray diffraction suite dedicated to materials characterisation is shared between Chemistry and Physics.

The Chemistry Department has a dedicated, well-supported Mass Spectrometry Suite comprising GC-MS, MALDI-TOF, and several state-of-the-art ESI-MS instruments with a variety of hyphenation and fragmentation capabilities. It also hosts the unique Fourier-Transform Ion Cyclotron Resonance Mass Spectrometry research laboratory, which is dedicated to the development and application of next-generation FTICR mass spectrometers. The purpose-built Elemental Analysis Facility in Chemistry comprises new inductively-coupled plasma spectrometers (OES and MS).

Our Analytical Science students benefit from hands-on training on such state-of-the-art research instruments.
Warwick Centre for Analytical Science (WCAS)

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