INTRODUCTION

This programme is designed to produce Masters graduates who have an in-depth knowledge of instrumentation involved in Materials analysis and characterisation together with a detailed knowledge of Materials Science, Materials Processing, and Surface Technology. The specialist modules will allow students to become fully briefed in the material science and engineering associated with high strength materials used in the aero-industry or with techniques for materials and coatings selection design, together with the materials selection methods typically employed by engineering consultants. From this knowledge base, graduates could expect to work in many manufacturing sectors or consultancy or, to continue their education to PhD level.

OBJECTIVES

The objectives of the programme are:

- To provide science, engineering and technology graduates with a competitive edge for a career in high technology manufacturing industries
- To provide graduates with analytical skills and knowledge which prepare them for careers in manufacturing, R & D or product / process design
- To develop graduates with excellence in Materials Science and Engineering capability to underpin National and International Industrial development
PROGRAMME OF STUDY
This Master of Science course is a two Semester plus Summer full time programme based on a modular credit system (90 ECTS) and the course outline is given below. In Semester 1, students study analytical techniques (microscopy, electron microscopy and X-ray analysis; X-ray diffraction; IR-, UV- and Raman-spectroscopy, particle size analysis, NMR spectroscopy, specimen preparation), structure of materials (structure – mechanical property relationships for metals, polymers and ceramics, phase transformations with associated strengthening effects, failure processes), advanced materials processing (manufacturing with metals, ceramics, polymers and composites and typical coating methods).

Semester 1 also includes the study of typical management systems which are needed to standardize and audit manufacturing processes and systems in Industry. Semester 2 involves further study of analytical techniques and modelling software used for materials development / analysis and affords students exposure to Research challenges in Materials Science. Students choose one elective covering the detailed materials science / engineering associated with composite materials or aerospace metallic materials, and one elective in Semester 2 from either materials selection and design (interaction between material properties and engineering design criteria, in designing components and products for manufacture, computer aided materials selection) or surface degradation and protection (coatings for improved oxidation, corrosion and wear resistance).

During Semester 2 students choose and begin work on a 45 credit research project supervised by world class researchers in Materials Science & Engineering. These projects involve the use of state of the art instrumentation at the University to acquire information on materials and processes suitable for high impact publications or IP protection.

CAREERS
Graduates will typically pursue careers in manufacturing in metallurgical, ceramic, polymer and composite technologies related to a diverse range of manufacturing sectors e.g. aerospace components and engines (including repair), chemical processing and process plant, power generation plant and many other manufacturing Industries. M. Sc. graduates in Advanced Engineering Materials would also be expected to gain employment in consultancy, research and development, product and process development or quality control and assurance.

ENTRANCE REQUIREMENTS
Applicants for a Master’s programme must normally have a first or second class Level 8 honours degree (NFQ or other internationally recognised equivalent) in a related physical science or engineering subject(s) or equivalent prior learning that is recognised by the University as meeting this requirement. Applicants must also satisfy the English Language Requirements of the University. The University reserves the right to shortlist and interview applicants as deemed necessary.

PROGRAMME OUTLINE

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FEES
Information on fees and semester dates is available from the university webpage www.ul.ie/finance.

CONTACT
Applicants who wish to discuss detailed elements of the programme may contact the Course Director:

Prof. Mike Pomeroy
Email: michael.pomeroy@ul.ie
Tel: +353-61-202 200
Web: www.cems.ul.ie

HOW TO APPLY
Please apply online at www.graduateschool.ul.ie
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Fax: +353 61 233287
Email: postgradadmissions@ul.ie
http://www.graduatestudies.ul.ie

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SEMESTER ONE CORE MODULES outline content

MT5001 STRUCTURE OF MATERIALS

MT6011 ADVANCED CHARACTERISATION OF MATERIALS 1
Microscopy: image formation, resolution, light microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning transmission electron microscopy (STEM). Diffraction and scattering: elastic and inelastic scattering, Bragg’s law, the reciprocal lattice, Laue equations, x-ray diffraction (XRD), selected area electron diffraction in the transmission electron microscope (SAD). Scanning probe microscopy, atomic force microscopy, scanning tunnelling microscopy. Spectroscopy: energy-dispersive x-ray spectroscopy (EDS), x-ray photoelectron spectroscopy (XPS), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, solid state nuclear magnetic resonance (NMR), mass spectroscopy, secondary ion mass spectroscopy; Thermal analysis, differential scanning calorimetry; Particle size analysis, porosimetry, surface area measurements.

MT6021 ADVANCED MATERIALS PROCESSING
Metallurgical forming: Casting, rolling extrusion, drawing, development of grain structure for specific properties, Polymer processing: extrusion, injection moulding blow moulding, rotational moulding, vacuum forming and related processes processing of cellular polymers, Processing of composites: lay up methods, press / autoclave / resin transfer moulding, RRIM, poltrusion and filament winding, Powder metallurgy and ceramic processing: green fabrication methods, sintering, hot pressing, HIPping, spark plasma sintering, development of microstructure in powder processed materials, Coating methods: PVD methods, CVD methods, electro-deposition and electroforming methods, joining: fusion welding, solid state welding, adhesive bonding and mechanical joining machining: Electromachining (electrochemical and electro-discharge) and mechanical machining

MT6031 MANAGEMENT SYSTEMS STANDARDS
M. Sc. ADVANCED ENGINEERING MATERIALS

SEMESTER 2 CORE MODULES outline content

CH6002 RESEARCH CHALLENGES IN MATERIALS SCIENCE
Detailed overview of advanced research topics in Materials and Surface Science, National and EU programmes in Materials and Surface Science, forefront research in Materials and Surface Science, use of latest experimental techniques used in preparation and analysis in Materials and Surface Science research, exposure to world experts in students own and other specialist area. Support original, independent and critical thinking, and ability to develop theoretical concepts.

MT6032 ADVANCED CHARACTERISATION OF MATERIALS 2
Magic Angle Spinning - Nuclear Magnetic Resonance spectroscopy (MAS-NMR), Detailed X-ray analysis: e.g. analysis of mesoporous materials, order/disorder, crystallite size, small angle scattering, preferred orientation, residual stress / strain, prediction of X-ray diffraction data using atomistic modelling software, Detailed backscattered electron diffraction analysis, electron and FIB tomography, Fine structure analysis: high energy diffraction (radial distribution function {RDF}), Extended X-ray Absorption Fine Structure (EXAFS) and variants, nanoindentation, profilometry, Materials modelling: understanding of HSC Chemistry, Factsage, Calphad, MTDATA and Dictra packages, molecular dynamics methods, prediction of material properties and FTIR / Raman spectra.

MT6042 MATERIALS PROJECT 1
Definition of research project title in conjunction with MSSI member / researcher with potential for development or original information, Definition of problem area, Appraisal of relevant literature, Definition of project aims and objectives, Development of project plan to achieve project aims and objectives, Definition of experimental technique requirements, Preparation and delivery of written and oral interim presentations, Collection of experimental data, rationalisation of that data with existing knowledge, writing up and oral presentation of research findings with clear conclusions derived from the rationalisation. The final deliverable from the research project will be a paper of between 6,000 and 8,000 words which will be reviewed and graded by the project supervisor and an independent academic as well as the external examiner.

SUMMER CORE MODULE outline content

MT6003 MATERIALS PROJECT 2
Continued appraisal of relevant literature, Continued collection of experimental data, rationalisation of that data with existing knowledge, writing up and oral presentation of research findings with clear conclusions derived from the rationalisation. The final deliverable from the research project will be a paper of between 6,000 and 8,000 words which will be reviewed and graded by the project supervisor and an independent academic as well as the external examiner.
## M. Sc. ADVANCED ENGINEERING MATERIALS

### ELECTIVE MODULES outline content

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**MT4107 COMPOSITE MATERIALS**


**MT6052 SURFACE DEGRADATION AND PROTECTION**

Basic electrochemistry associated with corrosion: electrode potentials, activation overpotential, concentration overpotential, IR drop, potential – current density curves: galvanic, intergranular, selective leaching and differential aeration corrosion mechanisms, mechanically aided corrosion aided corrosion mechanisms – exfoliation, cavitation and stress corrosion cracking: cathodic protection, metallic/ceramic/polymeric coatings for aqueous corrosion protection. Thermodynamics and kinetics of high temperature oxidation; thermodynamics and kinetics of high temperature corrosion, corrosion by deposits (gas turbine corrosion) self protection of alloys by formation of chromia or alumina coatings, coating chemistries for oxidation and corrosion protection of alloys, chromide, aluminide and silicide coatings, overlay MCrAlY coatings, smart coatings, formation of coatings. Friction & wear, wear mechanisms, adhesive, abrasive (gouging, ploughing) protection from wear - hard material coatings, multi-layered coatings: heat treatments & mechanical working processes to develop wear resistant surface layers.