The University of Liverpool
Department of Engineering

Taught Masters Programmes for 2009 and Beyond

Engineering Applications of Lasers

Introduction

Engineering Applications of Lasers is a 1-year full-time programme leading to the degree of MSc(Eng). It consists of nine taught modules (many with direct involvement of industry experts) and a major industrially relevant project which is submitted as a dissertation.

The aim of the programme is to train engineers and scientists in the application of optical energy by developing an in-depth understanding of the science and engineering of the use of high power lasers together with a strong emphasis on how they are used in industry. This approach is strengthened by the achievement of practical experience using laser systems in dedicated laboratory sessions and in the dissertation project. The engineering implications of new laser-based processes are developed in specific modules as are the fundamentals of optics and the economics of laser processes. Professional skills modules in effective management, communication skills and understanding organisations are also provided.

The programme is supported by EPSRC with scholarships for UK based and EU based applicants. International students may apply for a Faculty of Engineering scholarship to assist with their fees costs. The Department of Engineering was awarded the highest grade attainable (5*) in the last Research Assessment Exercise.

Format

The programme consists of two distinct parts; an eight month lecture and practicals programme running from September until May, and a substantial research project which starts the following January and finishes in September of the same year. The content of the programme is organised as seven laser based modules, plus related technology modules & personal / research skills modules. The module structure allows the grouping the theoretical and practical activity in a given topic area together with input from industry practitioners to provide a comprehensive and concentrated overview of each topic. The taught part of the course is assessed in January and May and represents 120 credits from a total of 180.

Module titles, timings and credit values

Module	Semester	Credits
Introduction to Laser Materials Processing	1	10
Optics & Optical Effects in Laser Engineering	1	10
Laser Welding	1	10
Economics of Laser Processes	1	10
Rapid Prototyping	1	7.5
Personal & Employability Skills	1	7.5
Laser Cutting	2	10
Laser Surface Processing	2	10
Laser Microprocessing	2	10
Smart Materials	2	7.5
Research Skills, Planning & Development	2	20
Research Skills	2	7.5

Projects

Project work is undertaken within one of our research groups and contributes 60 credits. Preliminary work is undertaken in semester 2 (including a 20 credit project preparation module) and becomes full-time from June onwards. The project is examined by dissertation and oral presentation, and award of the M.Sc.(Eng.) degree will require evidence of in-depth understanding, mastery of research techniques, ability to analyse assembled data, and assessment of outcomes.

Admission

The normal entry requirement is a good first degree in an appropriate branch of engineering or science. Individual consideration is given to mature engineers with significant and relevant experience and with professional qualifications. All graduates of non-UK universities are required to provide evidence of satisfactory communication skills in the English language. Acceptable English Language qualifications include IELTS 6.0 or GCSE grade C. Other equivalent qualifications will be also considered.

M.Sc. (Eng.):
A Bachelors Degree 2.2 or higher in an appropriate field of study from a UK institution or an equivalent degree from an overseas institution.

Applicants are required to provide evidence of suitable financial support capable of meeting all University Fees and personal expenses.

Further Information

Requests for further information, scholarship details and application forms should be made to:

Student Support Office, (PG)
Department of Engineering,
University of Liverpool, Derby Building
Liverpool L69 3GH, UK.
Tel: **+44 151 794 4857 / 794 4902,**
Fax: **+44 151 794 4901**
Email: **pgeng@liv.ac.uk**
URL: **http://dbweb.liv.ac.uk/engdept/**

Further information can also be found at:
http://www.lasers.org.uk

The University of Liverpool - Department of Engineering

M.Sc. (Eng.) in Engineering Applications of Lasers

Programme module details

MECH611 Introduction to Laser Materials Processing (10 credits)

Lecture content (80%): Overview of Laser Materials Processing; Introduction to the applications of optical energy; Laser construction, design & beam properties; Reporting scientific results; Introduction to laser safety; Introduction to high power laser processes (laser cutting, laser welding, laser surface treatment, laser cladding, laser forming); laser applications in aerospace; laser applications in the automobile industry; laser materials processing in small businesses. Practical content (20%): Safety in the laser laboratory; High power industrial lasers & their basic operation; Laser processing parameters.

MECH612 Optics and Optical Effects in Laser Engineering (10 credits)

Lecture content (80%): Fundamentals of optics and optical effects; Basic optics - the nature & properties of light, geometrical optics: interference, diffraction, scattering, coherence; Laser optics - resonant cavities, Gaussian optics, cavity modes, spontaneous and stimulated emission, gain, mode-locking, Q-switching, beam characteristics; Laser beam engineering: optical components - beam propagation, divergence, optical fibres, diffractive elements, lens arrays, modulation, polarisation, non-linear effects; Diagnostic techniques using lasers; Laser-material interactions. Practical content (20%): Ray tracing and optical design for laser beam propagation, using optical design software; Investigation of beam parameters in free-space and fibre delivery; Propagation parameters of high power laser beams.

MECH617 Economics of Laser Processes (10 credits)

Lecture content (80%): Introduction to the economics in laser processing, competitive processes, application examples; Markets and macroeconomics - review of growth in worldwide sales & usage of lasers; Economic assessment - economic factors & costs; Lasers in research -; introduction to research methods; dissemination of research results; Lasers in business - setting up a company; Interface between lasers & the design process; E-commerce and lasers - the role of lasers in research knowledge, marketing and business operation; Scientific knowledge and research methods. Practical content (20%): Laser business simulation; Preparing a business plan for a laser based business.

MECH614 Laser Welding (10 credits)

Lecture content (80%): Introduction to laser welding technology & competing processes; mechanisms (conduction & keyhole welding modes); process parameters v. weld quality; comparisons with competing processes; Thermal models for laser processing; Mathematical modelling of the laser welding process; Materials aspects of laser welding; Diagnostics and in-process sensing in laser welding. Practical content (20%): Modelling of laser conduction welding using a software package; CO_2 laser welding of sheet & thin plate steels; Laser spot welding using a pulsed Nd:YAG laser.

MECH616 Laser Cutting (10 credits)

Lecture content (80%): Introduction to laser cutting technology and competing processes - mechanisms of laser cutting (melt and blow, reactive gas laser cutting); simple model for estimation of relationship between cutting rate, laser power and sheet thickness; applications; comparison with competing processes; Fundamentals and industrial practice in CO_2 laser cutting; Aerodynamics of laser cutting and thick-section cutting techniques; Developments in high speed laser cutting techniques; Nd:YAG laser cutting. Practical content (20%): Laser cutting parameters; Effects of assist gas pressure on laser cut quality; Investigation of nozzle flow characteristics using Schleiren techniques.

MECH616 Laser Surface Processing (10 credits)

Lecture content (80%): Laser transformation hardening & annealing; Laser surface melting - Marangoni flow; enhanced solid solubility; micro-structural changes; effects on corrosion, hardness & wear; Laser surface alloying; Laser cladding - applications in prototyping and repair; Laser forming - principles, equipment, process parameters, techniques and applications; Laser cleaning - process mechanisms, mathematical models, applications in art conservation and industrial cleaning; Direct laser deposition and comparison with rapid prototyping. Practical content (20%): Laser Cleaning using a Nd:YAG laser; Laser Cladding with a high power CO_2 laser; Direct Laser Deposition (DLD).

MECH621 Laser Microprocessing (10 credits)

Introduction to laser microprocesses; Laser microcutting - techniques and applications; Laser drilling - mechanisms, effect of process parameters; Laser marking - mechanisms of marking in different materials, vector marking, raster scanning; Laser microforming - mechanisms & parameters for microforming, microactuators, applications in metals, ceramics, polymers; Laser microdeposition - Process principles; microdeposition systems; Direct Writing; Laser micromachining - ablation mechanisms in micromachining; applications in metals, ceramics and semiconductors; Laser microwelding and soldering; Novel laser microprocesses. Practical content (20%): Laser microforming; Laser percussion drilling; Laser marking.

ENGG598 Research Skills, Planning and Development (20 credits)

Techniques & scientific/technical methods for MSc(Eng) research project planning; Attendance of Department Research Group lectures/activities; Organising time, equipment and people; Gantt charts, report writing, technical support services; Information gathering from library, e-sources and external data sources; Data analysis, graphic presentation & dissertation writing; Introduction to Liverpool environment for computational studies.

MNFG610 Rapid Prototyping (7.5 credits)

Rapid Product Development and Rapid Prototyping (RP) technology; principles of stereolithography, fused deposition modelling, selective laser sintering & 3D printing; Data interface for RP; Recent developments (emerging RP processes, rapid tooling, rapid manufacture); laboratories.

MATS515 Smart Materials (7.5 credits)

Smart systems & materials in technology & nature; Transducer principles & material properties, sensors & actuators; Integration: limits to top-down smart systems assembly & miniaturisation, micro-electromechanical devices, 'bottom-up' assembly methods, molecular self-assembly; Case studies.

PGSC001 Personal & Employability Skills (7.5 credits)

Effective communication & presentation; Team working**;** Leadership and negotiation; Individual & self-assessment skills related to employability; Team-based practical work (practical problem solving, including use of time management, physical & human resources).

PGSC001 Research Skills (7.5 credits)

Information retrieval & databases; Bibliographic databases for informatics; Health & safety issues; responsible working practice; Intellectual Property Rights (IPR); Technology transfer; Presenting research in context.

Recommended Text

The recommended text for the programme is: W M Steen *Laser Material Processing 3rd Edition* (Springer, London) 2003 (ISBN:1852336986).