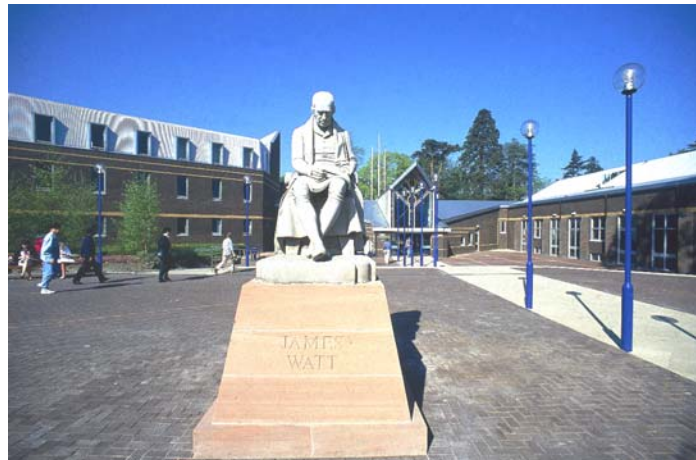


Microsystems Engineering

**A Series of Short Courses for
Continuous Professional Development**

October – December 2002

The School of Engineering
and Physical Sciences,
Heriot Watt University,
Edinburgh EH14 4AS, UK.



Funded by the EPSRC



Organised by the MISEC



Why these Short Courses

With the capability of actuation, sensing as well as electronic information processing afforded through miniaturised engineering structures, *microsystems* are widely used in the latest IT and telecommunications hardware, advanced medical devices, and various biomedical and biotechnological fields. In recent years, microsystems technology, also known as *microengineering*, has been growing rapidly in terms of both technological advancement and commercial expansion despite the hi-tech slowdown and macroeconomic adversity. To keep pace with the rapid development and to cope with the adverse economic climate, it is necessary for engineers and managers already in the microengineering industry to update and broaden their knowledge and skills, in addition to systematic advanced training of recent graduates entering the microengineering profession. To satisfy the industrial demands, MISEC has recently developed the TIME (Training In Micro-Engineering) course, the first and only course in the UK solely devoted to microsystems engineering to provide specialist training at the master level. The value of the TIME course is reflected in one way in the full financial backing by the EPSRC. These short courses are parts of the TIME course.

For Whom the TIME Course is Designed

The TIME course is designed for two types of participants:

- (A) recent graduates in electrical engineering or a related discipline aiming for an MSc or PGDip through systematic full-time or part-time study, and
- (B) industrial delegates pursuing continuous professional development (CPD) by studying selected topics of interest. (CPD participants can register retrospectively for an MSc if it is desired.)

Objectives of the TIME Course

- ☞ To provide advanced training in all aspects of microsystems technology ranging from design, modelling, fabrication, and characterisation to packaging, assembly and testing.
- ☞ To keep participants abreast with the latest industrial practice and research development in all major technological areas related to microsystems.
- ☞ To develop business skills as well as core technical skills necessary in the microengineering profession.

Course Structure and Delivery

To suite both types of participants, the TIME course is organised into stand-alone topical modules requiring minimum technical background. Each module is delivered in a one-week

block in the form of lectures, tutorials, and practical laboratory work. Lectures are presented using modern media technology in a combined classroom/laboratory equipped with state-of-the-art computing facilities, and are accompanied with professionally prepared high-quality course notes.

The University, MISEC, and its Collaborators

Heriot Watt University is well known as an industry-led technological university with research funding from industry ranking the top 5 and graduate employment the top 10 universities in the UK.



Engineering and computing are particularly strong in the University, achieving commendable academic standards and the highest possible ratings by the QAA (Quality Assurance Agency).



Located about 5 miles southwest of Edinburgh, the University enjoys both the country tranquillity and the urban attractions. The University campus, developed on a scenic ancient garden with outstanding natural beauty, hosts a number of shops, clubs, cafeterias and accommodation facilities, supporting a convenient, rich and enjoyable campus life.

MISEC comprises the expertise in wide areas in microengineering of 12 members of academic staff across four departments of Heriot Watt. There are also over 20 research associates and PhD researchers. With first-class facilities and an excellent track record in R&D, the centre has forged close links with over 30 companies and attracted over £1.3M of funding. It's fast becoming a centre of excellence.

Delivery of the TIME course also involves substantial collaboration between MISEC and a number of other institutions, including The University of Edinburgh, The University of Strathclyde, The University of Glasgow, The Institute of System level Integration, the Scottish Microelectronics Centre and CLRC.

Course Lecturers

Apart from the wide expertise of MISEC and its collaborators, a large number of lecturers are specially invited from well-known academic and industrial institutions worldwide to ensure that each topic of the course is covered by leading experts in the field so that all the objectives and an overall high quality of the course are achieved. Course lecturers for the 2002 autumn term include the following:

Dr Marc Desmulliez, MIEE, MInstP, CPhys, CEng

Marc Desmulliez is a Reader in the School of Engineering and Physical Sciences at Heriot Watt University and the Director of MISEC (the MicroSystems Engineering Centre). He is also the Chairman of the IEE Professional Network in Microsystems/Nanotechnology. Dr Desmulliez's interests in microsystems include advanced MEMS assembly and packaging, UV-LIGA processes, design of MEMS and the use of optics in MEMS. Dr Desmulliez is the grant holder of 5 current research projects in the MEMS field in which he has published over 60 papers.

Dr Resh Dhariwal, CPhys, MInstP

Resh Dhariwal is the Director of the TIME MSc course in microsystems engineering. He has been working in the area of microsystems for 12 years as the principal investigator or co-investigator of many European and EPSRC projects. He is an invited member of the IEE Technical Advisory Panel for the Microsystems/Nanotechnology Professional Network. He has been the author/co-author of around 40 research papers. Currently he is working on 3 EPSRC research projects. His main interest is in the area of fluidic devices.

Professor Ulrich Beerschwinger

Ulrich Beerschwinger is Professor in Design and Machine Elements at the Ingolstadt University of Applied Sciences, Germany. He received his PhD in microsystems from Heriot Watt University in 1992. Dr Beerschwinger has a strong industrial background in R&D of electromechanical devices. He spent more than 8 years in the industry working for companies like Audi and Alcatel. His interests in microsystems include designing methodologies, CAD tools (for designing, simulation and modelling), MEMS packaging, microactuators and virtual prototyping. He holds 9 patents and has numerous articles published in refereed journals or presented to conferences. He is a Member of the American Society of Mechanical Engineers.

Miss Nora Finch

Nora Finch is a Software Partnerships Manager at Corning IntelliSense Corporation, USA, where she is involved in business development activities while overseeing the

University Partnership Program. Since joining Corning IntelliSense, Ms. Finch has also been involved in applications engineering, training, and technical support, and software development for IntelliSuite. She received a Master of Engineering in High Performance Structures as well as a Bachelor of Science from MIT.

Professor Bob Reuben, BSc, PhD, CEng, FIM, FIMechE, ILTM

Bob Reuben is Professor of Materials Engineering in the School of Engineering and Physical Sciences at Heriot Watt University. He has had a research interest in microsystems for around 12 years, with a specialism in micromechanics. A particular feature of this work has been in the development of actuators, particularly, although not exclusively, for medical applications. This work is also complemented by other work on medical devices, such as in shape-memory alloys for orthodontic applications and the microfabrication of devices using SMAs.

Professor Wolfgang H. Müller,

Wolfgang H. Müller is Professor für Kontinuumsmechanik und Materialtheorie at the Technische Universität in Berlin. His research is mainly in the field of theoretical engineering, including continuum theory and modelling of the performance and behaviour of advanced materials and technical structures, fracture and damage mechanics (“fracture electronics” in particular), numerical mathematics and computer simulations, experimental determination of micro-mechanics parameters, and thermodynamics and materials theory. He has received several awards from SMTA, CNRS, and the Senate of Berlin for his work in these fields. He received a PhD in Physical Engineering Science in 1986 from the Technische Universität in Berlin. In 1997 he was awarded the Venia Legendi in Technical Mechanics at the Universität Paderborn. He has worked in the industry as well as in academia at various places including Siemens in Munich, the Hermann-Föttinger Institut in Berlin, Stanford and UC Santa Barbara. He has been Professor and Chair (1999-2000) of Mechanical Engineering at Heriot Watt University. His work on micro-mechanics has been funded by NASA, EPRI, DFG, and EPSRC. He is a member of ASME, ASTM, DHV, GAMM and STMA.

Professor A. J. Sangster, BSc(Eng.), MSc, PhD, FIEE, CEng
A. J. Sangster received a B.Sc. in Electrical and Electronic Engineering in 1963, an M.Sc. in 1964, and a Ph.D. in 1967, all from the University of Aberdeen in Scotland. He spent four years with Ferranti plc, Edinburgh, Scotland, doing research into wide-band travelling wave tubes, and three years with Plessey Radar Ltd., Cowes, U.K., investigating and

developing microwave devices and antennas for microwave landing systems and frequency scanned radar systems. Since 1972, he has been with Heriot Watt University, Edinburgh, where he became Professor of Electromagnetic Engineering in 1989. He has recently become a director (part-time) with Microsulis Medical Ltd. He is a Fellow of the Institution of Electrical Engineers (U.K.), and a Member of the Electromagnetics Academy (U.S.A.). His current research interests lie in the areas of microwave antennas, mm-wave sensing, electrostatically driven micromotors and microactuators, electromagnetic levitation, medical applications of microwaves, and the numerical solution of electromagnetic radiation and scattering problems. He is the author of over 150 papers on these topics.

Dr Feng-Bin Li, BSc, MSc, PhD

F. B. Li received a PhD in 1990 from Imperial College London and has since been conducting research in several UK universities in various scientific and technological areas, including chemical sensors and miniaturized sensor arrays, electrically conducting polymers and devices, thin film deposition and characterization, and quartz crystal microbalance monitoring. He has about 30 papers published in international journals. He is the Lecturer/Course Developer of the TIME MSc course in microsystems engineering at Heriot Watt University.

Professor Anthony J. Walton,

Anthony J. Walton is a Professor in the Department of Electronics and Electrical Engineering at The University of Edinburgh. He received a BSc degree in Electrical and Electronic Engineering in 1974, and an MSc degree by research in 1976. After receiving his PhD from Manchester Polytechnic in 1979 he joined the Department of Electronic and Electrical Engineering, University of Technology, Loughborough, as a Research Fellow working on hybrid active filters. In 1981 he moved to the Edinburgh Microfabrication Facility in the Department of Electrical Engineering at the University of Edinburgh, addressing process control and measurement problems associated with integrated circuit fabrication. Since that time he has been involved with the microelectronics industry in a number of areas which include silicon processing, microelectronic test structures, Design for Manufacturability (DFM) and Technology Computer Aided Design (TCAD). His present interests also include the optimisation of semiconductor processes through the integration of the experimental design and TCAD simulation tools. He has about 220 publications.

Mr Alan M. Gundlach

Alan M. Gundlach received a BSc in Physics in 1959 and an MSc in 1965, both at the University of London. He was employed in the semiconductor industry for 19 years from 1959, initially with A.E.I. Radio and Electronics Components Division and with Texas Instruments Ltd. working on the manufacture of bipolar discrete devices and integrated circuits and, latterly, with Elliott Automation Microelectronics Ltd. and with General Instrument Microelectronics Ltd. as MOS Process Development Manager. In 1978 he was appointed to a Senior Research Fellowship at the University of Edinburgh in the role of Operations Manager of the Edinburgh Microfabrication Facility, responsible for designing and installing processes ranging from silicon machining to complete CMOS fabrication sequences. He is currently Manager of the Edinburgh Microfabrication Facility in the Department and is involved with the microelectronics industry in a number of areas which include silicon processing, and process technology courses for semiconductor equipment manufacturers (JEMI).

Mr Mathias PEZ, Engineer, MSc in Electronics.

Mathias PEZ has been the Optical Interconnect Lab Manager at THALES Research & Technology – France until very recently. He is now the Chief Technical Officer and President of "D-Lightsys" (Digital and Lightwave Systems S. A.). Apart from optical interconnects and communications, Mathias PEZ's interests also include MEMS/MOEMS and advanced packaging. He is the grant holder of two patents in the field of optical communication and has published several papers in the optical interconnects field.

Dr Andrew S Holmes, MA, PhD

Andrew S Holmes is a Senior Lecturer in the Optical and Semiconductor Devices Group, Department of Electrical and Electronic Engineering, Imperial College London. Before joining the Department in 1995 he spent two years as a Research Fellow in Microsystems Technology at the Rutherford Appleton Laboratory. He has been principal or co-investigator on 12 research projects, and has published around 50 papers on optical signal processing, integrated optics and microsystems. His current research projects are in the areas of micropower generation/conversion, RF MEMS and laser processing for MEMS manufacture.

Dr David Wood, BSc, PhD, MIEE, CEng

David Wood is a reader in the School of Engineering at the University of Durham. He has been active in MEMS for over ten years. The initial research concentrated on silicon gyroscopes, but the scope has diversified considerably from

there. Current projects include RF MEMS, liquid sensors, magnetic probes, pressure sensors and handwriting recognition devices. The work is heavily involved with by industry, but also includes funding from EPSRC and local government agencies. Dr Wood has over 50 academic publications, 1 textbook and 2 patents as a result of his work.

Professor Phillip John BSc, PhD, DSc

Phillip John is Professor of Chemistry within the School of Engineering and Physical Sciences at Heriot Watt University and is the Director of ESAT (Edinburgh Surface Analysis Technology). One of his research interests is laser-materials interactions including laser ablation/ionisation phenomena including molecular desorption from surfaces. He has been awarded two Distinguished Visiting Scientists awards at the Laser Chemistry Division at the National Research Council of Canada in pursuance of this work. He is also on the Editorial Board of Advanced Materials/CVD. The other main research programme is on the chemical vapour deposition of electronic materials using thermal, laser and plasma sources. Over the past decade this has included the microwave plasma growth of thin film diamond for applications in chemical and biosensors. Professor John has published over 150 papers in these and related areas.

Professor Roger Whatmore,

Roger Whatmore is Professor of Engineering Nanotechnology and Head of Department at Cranfield University. He undertook his PhD at the Cavendish Laboratory, Cambridge University. He joined GEC Marconi Materials Technology (formerly Plessey Research) at Caswell in 1976, working on the applications of ferroelectric materials to piezoelectric, pyroelectric, dielectric and electro-optic devices. He has particularly specialised in their use in uncooled thermal imaging arrays and led the team that won the 1993 Prince of Wales Award for Innovation for their use in a firefighting camera. In that year he was also awarded GEC's Nelson Gold Medal. He had been Divisional Manager for the Sensors Division and Technical Director in the company. In October 1994 he took up the Royal Academy of Engineering Chair in Engineering Nanotechnology at Cranfield University, where he is exploring the applications of ferroelectric in microsystems and nanotechnology. Professor Whatmore has published over 180 journal and conference papers and has filed over 30 patents in the field of ferroelectric materials and their applications. Professor Whatmore's main areas of expertise are in ferroelectric materials and their applications, especially in pyroelectric, piezoelectric, dielectric and electro-optic devices; microsystems; and nanotechnology.

Course Fee, Accommodation and Registration

The course fee is £500 for three days of a module (Tuesday, Wednesday and Thursday are recommended except for the module ‘MEMS for Telecoms (MOEMS – RF-MEMS)’ which will be on Monday, Tuesday and Wednesday). *Considering that delegates from the industry may be interested only in some particular parts of a module or may not be able to spend time for a whole module, a flexible alternative of £200 for a single day of choice is also offered.* The fee covers tuition, a set of course notes, and drinks during lecture breaks. On campus accommodation is available at about £30 pppn. For registration, accommodation booking and further information, please contact:

*Dr Resh Dhariwal (course director),
Tel: +44 (0)131 451 3338, r.s.dhariwal@hw.ac.uk.
School of Engineering and Physical Sciences,
Heriot Watt University, Edinburgh EH14 4AS, UK.*

Modules for the 2002 Autumn Term

For the 2002 autumn term, five modules will be delivered as summarised in the table below.

Modules	Dates
Manufacturing Processes in Microengineering	14-18 Oct
MEMS for Telecoms (MOEMS – RF-MEMS)	28-30 Oct
Sensors and Actuators in MEMS	11-15 Nov
MEMS Modelling	25-29 Nov
Assembly, Packaging and Testing of Microsystems	9-13 Dec

Detailed contents and schedules of these modules are given below. Please note that the schedules may be subject to certain relatively minor changes without prior notice.



Manufacturing Processes in Microengineering

Monday 14th October 2002

- 9.15-10.15 Dr Marc Desmulliez , Heriot Watt University
MEMS, microdevices introduction.
- 10.15-11.15 Professor A. Walton, University of Edinburgh
Fundamentals of microsystems manufacturing
- 11.15-11.30 Coffee
- 11.30-12.30 Dr Marc Desmulliez,
Fundamental of material science,
mechanical properties of silicon
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr J. T. M. Stevenson, University of Edinburgh
Clean room design and operation
- 3.00 - 4.00 Dr Haworth, University of Edinburgh
Film deposition techniques (evaporation, CVD,
sputtering)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Dr J. T. M. Stevenson,
Photolithography resist coating,
exposure and development

Tuesday 15th October 2002

- 9.15-10.15 Professor A. Walton, University of Edinburgh
Ion implantation, diffusion and oxidation
- 10.15-11.15 Dr F. B. Li, Heriot Watt University
Bulk micromachining, wet etching
- 11.15-11.30 Coffee
- 11.30-12.30 Dr F. B. Li,
Surface micromachining, dry etching
- 12.30- 2.00 Lunch
- 2.00 -3.00 Dr L. Haworth, University of Edinburgh
Packaging and assembly: wafer and flip-chip
bonding
- 3.00 - 4.00 Mr Gundlach,
Wet etch lab: Photolithography deposition, etc
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Mr Gundlach,
Wet etch lab: Photolithography deposition, etc

Wednesday 16th October 2002

- 9.15-10.15 Dr Marc Desmulliez , Heriot Watt University
LIGA basic principles
- 10.15-11.15 M. Leonard, Heriot Watt University
Hands on LIGA patterning

11.15-11.30 Coffee
11.30-12.30 Kay and Leonard
Hands on LIGA electroforming - metrology
12.30- 2.00 Lunch
2.00- 3.00 Dr Marc Desmulliez,
LIGA selected topics
3.00- 4.00 Dr Joe Armstrong, Lambda Photometrics Ltd.
Metrology of MEMS: interferometry
4.00- 4.15 Tea
4.15- 5.15 Dr Resh Dhariwal, Heriot Watt University
Characterisation techniques: SEM, TEM EDAX
and WDX

Thursday 17th October 2002

9.15-10.15 Dr Resh Dhariwal, Heriot Watt University
Demonstration: SEM and X-ray analysis
10.15-11.15 Dr F. B. Li, Heriot Watt University
Scanning Tunnelling Microscopy (STM)
and Atomic Force Microscopy (AFM)
11.15-11.30 Coffee
11.30-12.30 Dr F. B. Li,
Demonstration: AFM
12.30- 2.00 Lunch
2.00- 3.00 Professor P. John, Heriot Watt University
Soft lithography technologies
3.00- 4.00 Dr Marc Desmulliez, Heriot Watt University
Mechanical test structures
4.00- 4.15 Tea
4.15- 5.15 Tutorial

Friday 18th October 2002

9.15-10.15 Tutorial
10.15-11.15 Dr Resh Dhariwal, Heriot Watt University
Demonstration repeat: SEM and X-ray analysis
11.15-11.30 Coffee
11.30-12.30 Drs Resh Dhariwal and Li
Demo. repeat: SEM and X-ray analysis; AFM
12.30- 2.00 Lunch
2.00- 3.00 M. Leonard, Heriot Watt University
Demo. repeat: Hands on LIGA patterning
3.00- 4.00 Kay and Leonard
Repeat: Hands on LIGA electroforming
4.00 - 4.15 Tea

MEMS for Telecoms (MOEMS – RF-MEMS)

In collaboration with Corning IntelliSense

Corning IntelliSense

Monday 28th October 2002

- 9.15-10.15 Dr Marc Desmulliez , Heriot Watt University
Introduction, welcome
- 10.15-11.15 Corning IntelliSense Corporation, USA
What are MEMS? MEMS markets
- 11.15-11.30 Coffee
- 11.30-12.30 Corning Research Centre, UK
MEMS technology for optical telecom
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr Marc Desmulliez, Heriot Watt University
MEMS processing (1/2)
- 3.00 - 4.00 Dr Marc Desmulliez, Heriot Watt University
MEMS processing (2/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Corning IntelliSense Corporation, USA
CAD Tutorial: AnisE

Tuesday 29th October 2002

- 9.15-10.15 Corning IntelliSense Corporation, USA
Introduction to MEMS modelling
- 10.15-11.15 Corning IntelliSense Corporation, USA
CAD Tutorial: The MUMPS process
- 11.15-11.30 Coffee
- 11.30-12.30 Corning IntelliSense Corporation, USA
CAD Tutorial: The RF-switch
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Digital and Lightwave Systems S. A., France
RF-MEMS (1/2)
- 3.00 - 4.00 Digital and Lightwave Systems S. A., France
RF-MEMS (2/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Digital and Lightwave Systems S. A., France
MOEMS

Wednesday 30th October 2002

- 9.15-10.15 Dr Marc Desmulliez, Heriot Watt University
Optoelectronics packaging landscape (1/2)
- 10.15-11.15 Dr Marc Desmulliez,
Optoelectronics packaging landscape (2/2)
- 11.15-11.30 Coffee
- 11.30-12.30 Corning IntelliSense Corporation
Cost models of MEMS for telecoms
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr Marc Desmulliez,
Optical alignment techniques (1/2)
- 3.00 - 4.00 Dr Marc Desmulliez,
Optical alignment techniques (2/2)
- 4.00 - 4.15 Tea



Sensors and Actuators in MEMS

Monday 11th November 2002

- 9.15-10.15 Professor Bob Reuben, Heriot Watt University
Stress and strain, elastic microstructure (1/2)
- 10.15-11.15 Professor Bob Reuben,
Stress and strain, elastic microstructure (2/2)
- 11.15-11.30 Coffee
- 11.30-12.30 Dr Marc Desmulliez, Heriot Watt University
Scaling laws
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr A. Holmes, Imperial College London
Plane statics
- 3.00 - 4.00 Dr A. Holmes
Bending and elastic forces
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Dr A. Holmes,
Dynamics of vibrating structures

Tuesday 12th November 2002

- 9.15-10.15 Dr Resh Dhariwal, Heriot Watt University
Actuation and sensing principles
- 10.15-11.15 Professor Alan Sangster, Heriot Watt University
Electrostatic actuation and actuators
- 11.15-11.30 Coffee
- 11.30-12.30 Dr Resh Dhariwal,
Hydraulic actuators - microturbines
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr F. B. Li, Heriot Watt University
Chemical sensors (1/2)
- 3.00 - 4.00 Dr C. Wang, Heriot Watt University
Optical sensing
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Dr C. Wang,
Optical sensors

Wednesday 13th November 2002

- 9.15-10.15 Professor Ulrich Beerschwinger, Ingolstadt
University of Applied Sciences, Germany
Case study: the electrostatic micromotor (1/2)
- 10.15-11.15 Professor Ulrich Beerschwinger,
Case study: the electrostatic micromotor (2/2)
- 11.15-11.30 Coffee
- 11.30-12.30 Dr F. B. Li, Heriot Watt University
Chemical sensors (2/2)
- 12.30- 2.00 Lunch

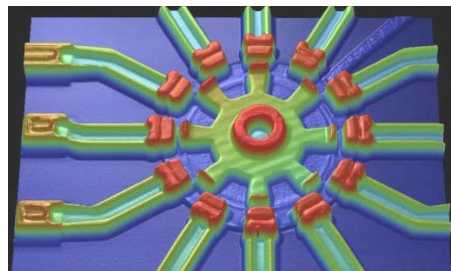
- 2.00 - 3.00 Dr David Wood, University of Durham
Accelerometer
- 3.00 - 4.00 Dr David Wood,
Pressure sensors: piezoresistive and optical
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Dr David Wood,
Laboratory work on accelerometers

Thursday 14th November 2002

- 9.15-10.15 Professor R. Whatmore, University of Cranfield
Functional materials for microsystems
- 10.15-11.15 Professor R. Whatmore,
Functional materials applications
- 11.15-11.30 Coffee
- 11.30-12.30 Professor R. Whatmore,
Piezoelectric actuators and motors for MEMS
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr F. B. Li, Heriot Watt University
Modelling of pressure sensors using ANSYS
- 3.00 - 4.00 Dr F. B. Li,
Modelling of pressure sensors using ANSYS
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Dr F. B. Li,
Modelling of pressure sensors using ANSYS

Friday 15th November 2002

- 9.15-10.15 Professor Bob Reuben, Heriot Watt University
Tutorial: Stress and strain
- 10.15-11.15 Dr Marc Desmulliez, Heriot Watt University
Tutorial: Planes statics
- 11.15-11.30 Coffee
- 11.30-12.30 Dr Marc Desmulliez,
Tutorial: Vibrating structures
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Professor Alan Sangster, Heriot Watt University
Tutorial: Electrostatic actuation
- 3.00 - 4.00 Dr F. B. Li, Heriot Watt University
Tutorial: Chemical sensors



MEMS Modelling

Monday 25th November 2002

- 9.15-10.15 Dr Resh Dhariwal, Heriot Watt University
Overview of modelling methodologies
- 10.15-11.15 Dr Marc Desmulliez, Heriot Watt University
Fundamentals of modelling techniques
- 11.15-11.30 Coffee
- 11.30-12.30 Dr Marc Desmulliez,
Case study: High level modelling of
micromotors
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Professor Alan Sangster, Heriot Watt University
MEMS analytical models (1/2)
- 3.00 - 4.00 Professor Alan Sangster,
MEMS analytical models (2/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Tutorial: Prof. Sangster, Dr Desmulliez,

Tuesday 26th November 2002

- The whole day by Professor W. Muller,
Technische Universität in Berlin
- 9.15-10.15 Introduction to SMT: typical components
- 10.15-11.15 Introduction to SMT: materials used
- 11.15-11.30 Coffee
- 11.30-12.30 Introduction to SMT: reliability materials
background
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Introduction to SMT: mechanical engineering
background (1/2)
- 3.00 - 4.00 Introduction to SMT: mechanical engineering
background (2/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 FE modelling of SMT components

Wednesday 27th November 2002

- The whole day by Professor W. Muller,
Technische Universität in Berlin
- 9.15-10.15 FE modelling of SMT components
- 10.15-11.15 FE modelling of SMT components
- 11.15-11.30 Coffee
- 11.30-12.30 FE modelling of SMT components
- 12.30- 2.00 Lunch
- 2.00 - 3.00 FE modelling of SMT components
- 3.00 - 4.00 FE modelling of SMT components

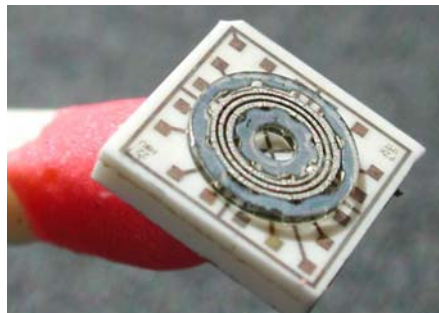
- 4.00 - 4.15 Tea
- 4.15 - 5.15 FE modelling of SMT components

Thursday 28th November 2002

- 9.15-10.15 Professor Ulrich Beerschwinger, Ingolstadt University of Applied Sciences, Germany
Lumped element analysis (1/2)
- 10.15-11.15 Professor Ulrich Beerschwinger,
Lumped element analysis (2/2)
- 11.15-11.30 Coffee
- 11.30-12.30 Professor Ulrich Beerschwinger,
Tutorial: Lumped element analysis
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr Resh Dhariwal, Heriot Watt University
Case study: pressure sensors (1/2)
- 3.00 - 4.00 Dr Resh Dhariwal,
Case study: pressure sensors (2/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Dr Marc Desmulliez, Heriot Watt University
Case study accelerometers

Friday 29th November 2002

- The whole day by Professor W. Muller,
Technische Universität in Berlin
- 9.15-10.15 FE Modelling of SMT components:
postprocessing
- 10.15-11.15 FE Modelling of SMT components:
postprocessing
- 11.15-11.30 Coffee
- 11.30-12.30 Student preparation of SMT modelling
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Student talks, reports and discussion
- 3.00 - 4.00 Student talks, reports and discussion
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Student talks, reports and discussion



Assembly, Packaging and Testing of Microsystems

Monday 9th December 2002

- 9.15-10.15 Assembly fundamentals
- 10.15-11.15 Packaging fundamentals
- 11.15-11.30 Coffee
- 11.30-12.30 Testing fundamentals
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Professor Bob Reuben, Heriot Watt University
Materials technology (1/2)
- 3.00 - 4.00 Professor Bob Reuben, Heriot Watt University
Materials technology (2/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Professor Bob Reuben,
Creep and fatigue (1/2)

Tuesday 10th December 2002

- 9.15-10.15 Professor Bob Reuben, Heriot Watt University
Creep and fatigue (2/2)
- 10.15-11.15 Dr A. Bosseboeuf,
Institut d'Electronique Fondamentale, France
Thin film mechanical characterisation (1/2)
- 11.15-11.30 Coffee
- 11.30-12.30 Dr A. Bosseboeuf
Thin film mechanical characterisation (2/2)
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr A. Bosseboeuf
Strain test devices for MEMS
- 3.00 - 4.00 Dr A. Bosseboeuf
Mechanical testing of MEMS (1/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Dr A. Bosseboeuf
Mechanical testing of MEMS (1/2)

Wednesday 11th December 2002

- 9.15-10.15 Dr A. Bosseboeuf,
Institut d'Electronique Fondamentale, France
In-situ & ex-situ measurement techniques (1/2)
- 10.15-11.15 Dr A. Bosseboeuf
In-situ & ex-situ measurement techniques (2/2)
- 11.15-11.30 Coffee
- 11.30-12.30 Dr A. Bosseboeuf
Other measurement techniques
- 12.30- 2.00 Lunch
- 2.00 - 3.00 M. Leonard, Heriot Watt University

MEMS inteferometry measurement lab

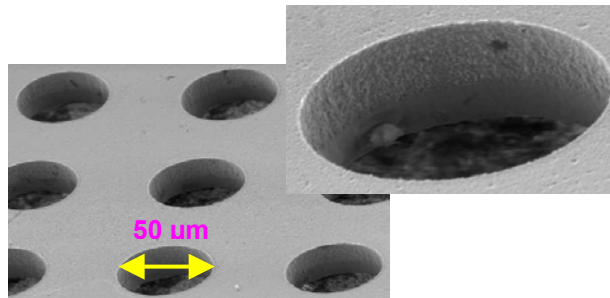
- 3.00 - 4.00 M. Leonard
Flip-chip bonding technology (1/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 M. Leonard
Flip-chip bonding technology (2/2)

Thursday 12th December 2002

- 9.15-10.15 Dr A. Richardson, University of Lancaster
Electrical test structures for MEMS (1/2)
- 10.15-11.15 Dr A. Richardson
Electrical test structures for MEMS (2/2)
- 11.15-11.30 Coffee
- 11.30-12.30 Dr Marc Desmulliez, Heriot Watt University
Special packaging schemes
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Dr Resh Dhariwal, Heriot Watt University
Packaging issues in microfluidics (1/2)
- 3.00 - 4.00 Dr Resh Dhariwal
Packaging issues in microfluidics (2/2)
- 4.00 - 4.15 Tea
- 4.15 - 5.15 Dr Marc Desmulliez
Packaging issues in optoelectronics

Friday 13th December 2002

- 9.15-10.15 Dr Marc Desmulliez, Heriot Watt University
Case study: MEMS accelerometer packaging
- 10.15-11.15 Dr F. B. Li, Heriot Watt University
Case study: Packaging for pressure sensors
- 11.15-11.30 Coffee
- 11.30-12.30 Dr C. Wang, Heriot Watt University
Case study: Flip-chip bonding of microsystems
- 12.30- 2.00 Lunch
- 2.00 - 3.00 Professor Bob Rueben, Heriot Watt University
Tutorial: Materials technology
- 3.00 - 4.00 Dr Marc Desmulliez
Case study: Alignment of optical fibres



Registration Form

Name (Prof/Dr/Mr/Ms/Mrs)

Job Title

Address

Postcode

Telephone Number

Fax Number

Email Address

Course Modules Interested

Days to Register

Signature Date

Method of Payment

The course fee of £ is enclosed.

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Please send an invoice to the following address for the sum of £

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Send completed form (or a photocopy) to:

Dr Resh Dhariwal, School of Engineering and Physical Sciences, Mountbatten Building, Heriot Watt University, Edinburgh EH14 4AS, UK. Fax: +44(0)131 4513327.