Aims

The aims of the course are to:

- introduce the principles of MEMS design and their application to a variety of microsystems.

Objectives

As specific objectives, by the end of the course students should be able to:

- extend the principles of microfabrication to the development of micromechanical devices and the design of microsystems
- understand the principles of energy transduction, sensing and actuation on a microscopic scale.
- appreciate the effects of scaling, and the similarities and differences between micromechanical assemblies and macroscopic machines.
- analyse and model the behaviour of microelectromechanical devices and systems.

Content

MEMS (MicroElectroMechanical Systems) technology enables the integration of mechanical, electrical, chemical, thermal, fluidic, magnetic and optical components on a microscopic scale together with elements allowing for the interconversion of energy between these different domains using fabrication techniques leveraged off microelectronics. MEMS technology has been widely perceived as a breakthrough in the creation of microsystems for applications ranging from smart sensors, biomedical devices, displays and imagers, telecommunications, computer peripherals and the automotive and aerospace sectors. MEMS devices operate on scales that are much smaller than is conventional: minimum feature sizes for micromachining processes often measure under a tenth of a micron, forces generated by microactuators range from piconewtons to millinewtons, and the displacement of microstructures can be measured to less than a picometer.

Introduction (1L, Dr A Seshia)
Overview of MEMS Technology
Scaling Laws
Objectives of MEMS Design

Micron-scale transduction (2L, Dr A Seshia)
- Energy-conserving transducers
- Transduction of deformation

Microfluidics (2L, Dr A Seshia)
- Microscale fluid flow
- Damping
- Electrokinetic Flow

Microactuators and Microsensors (4L, Dr A Seshia)
- Principles of Actuation
- Micromachines
- Force and Pressure Sensors
- Accelerometers and Gyroscopes

Contact mechanics at the micro-scale (4L, Prof JA Williams)
- Hertzian point contacts between elastic solids
- Surface energy and adhesion - JKR and DMT
- Condensation and meiscus effects

Coursework
The coursework will investigate the design and modelling of a MEMS electrostatic actuator subject to voltage control. The IntelliSuite MEMS CAD tool will be used for design verification.

Booklists
Please see the Booklist for Group C Courses [2] for references for this module.

Examination Guidelines
Please refer to Form & conduct of the examinations [3].

UK-SPEC
The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes’ (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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