MEMS Design Module - 4C15

Cambridge, Engineering Department

Leader:	Dr D Fenner (raf37@eng)
Timing:	Lent Term
Prerequisites:	None
Structure:	12L + 2 Examples Classes + coursework
Assessment:	***Material / Format / Timing / Marks/Credits***
	Lecture Syllabus / Written exam (1.5 hours) / Start of Easter Term / 75%
	Coursework / Report / 15 days after experiment / 25 %
	15 credits overall

AIMS

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 convertional: 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. This course aims to introduce the principles of MEMS design and their application to a variety of microsystems.

LECTURE SYLLABUS

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

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

3. **Microfluidics** (2L, Dr A Seshia)
    - Microscale fluid flow

- Damping
- Electrokinetic Flow

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

5. **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.

OBJECTIVES

On completion of the module 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.
- Be able to analyse and model the behaviour of microelectromechanical devices and systems

REFERENCES

Please see the **Booklist for Group C Courses** for references for this module.

http://to.eng.cam.ac.uk/teaching/courses/y4/Booklist-IIB-GrpC.pdf