Engineering Tripos Part IIB, 4C15: MEMS: Design, 2018-19

Leader

Prof A Seshia [1]

Lecturers

Prof A Seshia

Lab Leader

Prof A Seshia

Timing and Structure

Lent term. 12 lectures + 2 examples classes + coursework. Assessment: 75% exam/25% coursework.

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 semiconductor-based fabrication techniques. 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 10's of nanometers, 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

Transducers in MEMS technology (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
- Force and Pressure Sensors
- Accelerometers and Gyroscopes
- Resonators, oscillators and RF MEMS

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 meniscus effects

Coursework

The coursework will investigate the design and modeling of a MEMS electrostatic actuator subject to voltage control.

Coursework	Format	Due date & marks
Learning objectives: 1. To design a linear electrostatic microactuator for a hard disk drive application. 2. To explore MEMS design optimisation subject to manufacturing constraints.	Individual Report anonymously marked	Wed week 9 [15/60]

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].

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