## Proposed Institute Elective course

## Name: Introduction to MicroElectroMechanical Systems (MEMS)

**COURSE OUTLINE**: Introduction to MEMS, Scaling Effects, Microfabrication fundamentals, Mechanics and transduction at the microscale, Actuation and sensing methods – Electrostatic, Piezoresistive, Piezoelectric, Thermal, Electromagnetic, Resonant and tunneling. Capacitative sensors, Resonators, Lab on Chip devices, Microfluidics. Assembly techniques for MEMS and packaging.

**OBJECTIVE**: To provide an overview of different applications of MEMS in sensing and actuation and provide a basic understanding of construction and mechanics underlying these systems.

**COURSE CONTENTS**:

Introduction:
MEMS definition, applications, markets, technology development, history, rationale, scaling of forces and dimension

Microfabrication:
Bulk micromachining, surface micromachining, Non-conventional micromachining – microelectrodischarge machining, ultrasonic machining, laser micromachining, nano imprinting, focused ion beam machining, screen printing, soft lithography, injection molding, hot embossing, stereolithography.

Actuation and Sensing:
Mechanics at microscale – microstructural elements, Stiction and control. Actuation principles – Electrostatic, Piezoresistive, Piezoelectric, Thermal, Electromagnetic, Resonant and tunneling.

MEMS Applications:
Case studies of accelerometer, pressure sensor, microphones, ink-jet print heads, resonators, digital micromirrors and microfluidic devices.

Microfluidics:
Fluid dynamics at the microscale, electrokinetics, surface tension driven transport, microfluidics for DNA analysis, Lab-on-Chip applications, Micropumps, microvalves, mixers. Process

Integration:
Wafer bonding and packaging, Assembly techniques for MEMS.

## Reference Books:

**MEMS:**


• N. Maluf, *An introduction to microelectromechanical systems engineering,* Artech House 2000
Chang Liu, Foundations of MEMS (2nd edition), 2012
• W. Trimmer, *Micromechanics and MEMS: Classic and seminal papers to 1990*, IEEE
• G.T.A. Kovacs, *Micromachined Transducers Sourcebook*, McGraw-Hill, 1998
• M. Gad-el-Hak, *The MEMS Handbook,* CRC Press, 2002


**Microfluidics**:


• G. Karniadakis, A. Beskok, N. Aluru *Microflows and Nanoflows: Fundamentals and Simulation,* Springer 2005.
• Geshke**,** *Microsystem Engineering of Lab-on-a-chip Devices***,** John Wiley Sons, 2004
• P. Tabeling, *Introduction to microfluidics,* Oxford University Press, 2005.
• J Kutter, Y. Fintshenko, *Separation methods in microanalytical systems,* Taylor & Francis 2006
• N. T. Nguyen, S. Wereley *Fundamentals and Applications of Microfluidics,*
Artech House Publishers, 2002


**Design**:


• Stephen D. Senturia, *Microsystem Design*, Kluwer Academic Publishers, 2000


**Microfabrication**:


• S. A. Campbell, *Science and Engineering of Microelectronic Fabrication*, Oxford University Press, 2005.
• M. Madou, *Fundamentals of Microfabrication*, New York: CRC Press, 1997
• M. Elwenspoek, H. Jansen, *Silicon Micromachining*, Kluwer Academic Publishers, 2001
• P. Van Zant, *Microchip fabrication: a practical guide*, McGraw Hill 2004 (TK 7871.85 V36)
• D.V. Morga, K. Board, *An introduction to semiconductor technology*, Wiley 1990 (TK 7871.85.M585)
• P. Gise, R. Blanchard, *Modern semiconductor fabrication technology*, Prentice Hall 1986. (TK 7871.85 G48)