EE - 599o: Micro-Electro-Mechanical-Systems

Lecture Schedule	See Time Table	**Course Type, Semester**	Elective, Spring 2019
Credit Hours	Three	**Pre-requisite**	• Fundamentals of Semiconductor Devices • Fundamentals of Electromagnetics • Microelectronic Circuits
Instructor	Dr. Farooq Ahmad	**Contact**	ahmad123farooq@gmail.com drfarooq_mems@uet.edu.pk
Office		**Office Hours**	Wednesday: 4:00 pm to 7:00 pm Tuesday: 7:00 pm to 9:00 pm
Teaching Assistant	None	**Lab Schedule**	See Time Table
Course Description	Due to on-board sensors, actuators, a microcontroller, battery and software, MEMS can perform mechanical, electrical, optical, fluidic, neurological and other types of tasks. Sensors and actuators allow interfacing of electronic systems to the non-electronic world providing analog information through signal conditioning circuits to a microcontroller, which then interprets the information, makes appropriate decisions and implements those decisions via the actuators and micro-instruments. This course focuses on fundamentals of (a) micro- and nano-fabrication, micromachining, sensors and actuators, (b) capacitive MEMS, BioMEMS, polymer MEMS and RFMEMS, and (c) projects on latest developments in MEMS applications.		

	CLOs	**Description**	**Level**
Measurable Learning Outcomes	CLO1	Understand the operational theory of common MEMS sensors and MEMS actuators.	High
	CLO2	Identify situations where MEMS sensors and actuators would be ideal for application to various products	High
	CLO3	Apply the scaling-laws to determine if MEMS devices would perform better than existing non-micro scale devices.	Medium
	CLO4	Analyze the engineering science and physics of MEMS devices at the micro-scale including: electro-statics, thermodynamics, piezoresistive, piezoelectric, magnetism and optics with the help of Ansys EM.	High
	CLO5	Understand the fabrication methods used to build/construct MEMS and develop new ideas and applications for MEMS devices.	High

Textbooks	**REQUIRED**: Foundations of MEMS by Chang Liu, 2nd Edition, Prentice Hall, 2011 **OPTIONAL**:

	1) Senturia, S., Microsystems Design, Springer, 2000 2) Gregory T.A. Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998 3) S. M. Sze, ed., Semiconductor Sensors. New York: John Wiley, 1994. 4) R. S. Muller, et al., Microsensors. New York: IEEE Press, 1991. 5) M. Madou, Fundamental of Microfabrication, Inc. Boca Raton, FL., 1997
Grading Policy vis-à-vis CLO Mapping	• Class Participation (Not Attendance) 10% • Quizzes (~6 to 8; mostly unannounced) 20% • Midterm 30% • Final 40%

Lecture Plan

No. of Weeks	Topics	Readings
2	Introduction & Basics of Microfabrication Scaling Laws & Basics of Microfabrication Basics of Semiconductors and Resistivity Basic Concepts of Stress and Strain	1.0 – 1.3 2.0 – 2.5 CLO1 3.0 – 3.2 CLO3 3.2 – 3.4
1	Beam Mechanics: Deflection and Torsion Electrostatic Sensing and Actuation	3.4 – 3.9 CLO1 4.0 – 4.2 CLO2
2	Electrostatic Sensing and Actuation Thermal Sensing and Actuation Thermal Sensing and Actuation	4.2 – 4.5 5.0 – 5.5 CLO2 5.0 – 5.5
3	Piezoelectric Materials, and Piezoelectric Sensing and Actuation Piezoresistivity and case study with simulation	6.0 – 6.4 CLO2 CLO4
	Mid Term Exam	
2	Magnetic Actuation and Optical MEMS	8.0 – 8.2 CLO4 15 – 15.2 CLO5
2	Magnetic Actuation and case study with simulation tool	8.2 – 8.3 CLO4
2	Microfabrication Technologies, Surface Micromachining	10 – 11.3 CLO5
2	Advanced Microfabrication Technologies: LIGA, HARM, Assembly Bio MEMS Sup.	11.5 + Sup. Notes CLO5
	Final Exam	