COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC465	MEMS	3-0-0 -3	2016

Prerequisite : NIL

Course objectives:

- To understand the operation of major classes of MEMS devices/systems
- To give the fundamentals of standard micro fabrication techniques and processes
- To understand the unique demands, environments and applications of MEMS devices

Syllabus:

MEMS and Microsystems applications, Review of Mechanical concepts, Actuation and Sensing techniques, Scaling laws in miniaturization, Materials for MEMS, Micro System fabrication techniques, Micro manufacturing, Micro system Packaging, Bonding techniques for MEMS, Overview of MEMS areas.

Expected outcome:

The student will be able to:

i. Understand the working principles of micro sensors and actuators
ii. Understand the application of scaling laws in the design of micro systems
iii. Understand the typical materials used for fabrication of micro systems
iv. Understand the principles of standard micro fabrication techniques
v. Appreciate the challenges in the design and fabrication of Micro systems

Text Books:

1. Chang Liu, Foundations of MEMS, Pearson 2012
2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002

References:

1. Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000
2. Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994
3. Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997
4. Stephen D. Senturia, Microsystem design, Springer (India), 2006.
5. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001

Course Plan

Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	MEMS and Microsystems: Applications – Multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators – micro accelerometer –comb drives - Micro grippers – micro motors, micro valves, micro pumps, Shape Memory Alloys.	4	15%
	Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	3	

II	Flexural beams: Types of Beams, longitudinal strain under pure bending – Deflection of beams – Spring constant of cantilever – Intrinsic stresses	3	15%
	Actuation and Sensing techniques : Thermal sensors and actuators, Electrostatic sensors and actuators , Piezoelectric sensors and actuators, magnetic actuators	4	
FIRST INTERNAL EXAM			
III	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector, scaling in electrostatic and electromagnetic forces, scaling in electricity and fluidic dynamics, scaling in heat conducting and heat convection.	5	15%
IV	Materials for MEMS – Silicon – Silicon compounds – Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon, GaAs , Silicon Piezo resistors,	4	
	Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films, Micro System fabrication – Photolithography – Ion implantation- Diffusion – Oxidation – Chemicalvapour deposition – Etching	5	15%
SECOND INTERNAL EXAM			
V	Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining , LIGA process –Microstereo lithography	6	20%
	Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging	3	
VI	Bonding techniques for MEMS : Surface bonding , Anodic bonding , Silicon - on - Insulator , wire bonding , Sealing – Assembly of micro systems	3	20%
	Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS	2	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70% for theory and 30% for logical/numerical problems, derivation and proof.