Course Number and Name	
BEE026 & Micro Electro Mechanical Systems	
Credits and Contact Hours	
3 & 45	
Course Coordinator's Name	
Ms.Divya	
Text Books and References	
Text Books: 1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012. 2. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000. 3. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002. **References:** 1. Nadim Maluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000. 2. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton, 2001. 3. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002. 4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005. 5. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 2010.	
Course Description	
The objective of this course is to present the state of the art in the areas of semiconductor device physics and materials technology to enable the Nano electronics.	
Prerequisites	**Co-requisites**
Control System	Nil
required, elective, or selected elective (as per Table 5-1)	
Required	
Course Outcomes (COs)	
CO1: To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices. CO2:To educate on the rudiments of Micro fabrication techniques CO3: To introduce various sensors and actuators CO4: To introduce different materials used for MEMS CO5: To educate on the applications of MEMS to disciplines beyond Electrical and mechanical engineering	
Student Outcomes (SOs) from Criterion 3 covered by this Course	

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
CO1	H	H	L	L	H	M	M	L	L	L	L	L

CO2	H	H	L	L	M	M	M	L	L	L	L	L
CO3	H	H	L	L	H	M	M	L	L	L	L	L
CO4	H	H	L	L	H	M	M	L	L	L	L	L
CO5	H	H	L	L	H	M	M	L	L	L	L	L

List of Topics Covered

UNIT I INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication – Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT II SENSORS AND ACTUATORS-I 9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors – Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph – Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

UNIT III SENSORS AND ACTUATORS-II 9

Piezo resistive sensors – Piezo resistive sensor materials – Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

UNIT IV MICRO MACHINING 9

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies – Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process – Assembly of 3D MEMS – Foundry process.

UNIT V POLYMER AND OPTICAL MEMS 9

Polymers in MEMS– Polimide – SU-8 – Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon – Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.