Second SEMESTER 2020-21
Course Handout (Part – II)

Date: 08/01/2021

In addition to Part I (General Handout for all courses appended to the time-table) this portion gives further specific details regarding the course.

Course No. : BITS F415

Course Title : **Introduction to MEMS**

Instructor-in-charge : **SACHIN U BELGAMWAR**

1. **Scope and Objective of the Course:**

The course introduces the basic concepts in MEMS (Micro Electromechanical Systems) with a view to address a class of students from science and engineering disciplines. The discussion on topics like MEMS design, Microfabrication, Microfluidics, Microrobotics and Microsensors have been structured in the course plan. The objective of the course is to equip the students from various aspects and with basic knowledge of the area of MEMS.

2. **Text Book:**

T1. Tai-Ran Hsu, *MEMS and Micro systems Design and Manufacture*, Tata McGraw Hill, 2002.
T2. GK Anantha Suresh, et. al, Micro and Smart Systems, Wiley-India, 2010.

3. **Reference Books:**

(a) Nitaigour P. Mahalik, *MEMS*, Tata McGraw Hill, 2007

(b) Marc Madou, *Fundamentals of Microfabrication*, CRC Press, 2002.

(c) Chang Liu, *Foundation of MEMS*, Pearson Education Inc., NJ, 2006

(d) Nadim Maluf , *An Introduction to Microelectromechanical Systems Engineering* , Artech House, 2000.

(e) Stephen D. Senturia, *Microsystem Design* , Kluwer Academic Publishers, 2001

4. **Course Plan:**			
Topic		**No. of Lectures Chap. Sec.**	
(1) Overview of MEMS and Microsystems	2	Ch. 1(T1), Ref (a)	Introduction
(2) Working principles of micro-systems	4	Ch. 2(T1), Ref (a)	Introduction to different MEMS sensors and actuators
(3) Engg. Science for micro-system design and fabrication	4	Ch. 3(T1), Ch.3 (T2)	Study of basics of science which is used in MEMS like plasma physics, doping, diffusion, electrochemistry etc
(4) Engg. Mechanics for Micro-system Design	3	Ch. 4(T1)	Model the electromechanical sensors
(5) Thermofluidic Engg. & Micro-system Design	4		1. Need of fluid mechanics and basics of fluid mechanics. 2. Basic equation in continuum fluid dynamics. 3. Laminar fluid flow in circular conduits 4. Incompressible fluid flow in micro conduits 5. Over view of heat conduction in solid
(6) Scaling Laws in Miniaturization	4	Ch. 6(T1)	1.Introduction to scaling 2.Effect Scaling in Nature 3.Scaling in geometry 4.Scaling in rigid body dynamics 5.Scaling in Electrostatic Forces 6.Scaling in Electromagnetic Forces 7.Scaling in Electricity 8.Scaling in Fluid mechanics 9.Scaling in Heat transfer

(7) Materials for MEMS and Microsystems	3	Ch. 7(T1), Ref. (a)(b)	1. Introduction and Objectives 2. Substrate and wafer 3. Active substrate material 4. Silicon as a substrate material 5. Methods for fabrication of Silicon wafer 6. Silicon compounds 7. Silicon Dioxide 8. Silicon Carbide 9. Silicon nitride 10. Polycrystalline Silicon 11. Silicon Piezo-resistors 12. Gallium Arsenide 13. Quartz 14. Piezoelectric Crystal 15. Polymers
(8) Micro-system fabrication Processes	5	Ch. 8(T1), Ref. (a) (b)	Understand the basic microfabrication. 1.Photolithography 2.Ion Implantation 3.Diffusion 4.Oxidation 5.Thermal Oxidation 6.Thermal Oxidation Rates 7.Oxide thickness by colour 8.Chemical Vapour Deposition 9.Physical Vapour Deposition 10.Deposition by Epitaxy 11.Etching
(9) Micro-manufacturing	5	Ch. 9(T1), Ref. (a) (b)	1.Classification of Micro-manufacturing process 2.Comparison between Micro-Manufacturing Process 3.Bulk Micro-manufacturing process 4.Surface Micro-manufacturing 5.The LIGA Process 6.Summary of Micro-manufacturing
(10) MEMS Packaging	2	Ch. 11 (T1), Ch. 8(T2)	Understand different packaging techniques.
(11) Project work/presentation	5		

5. **Evaluation Scheme:**

Component	Duration	Weightage (%)	Date & Time	Remarks
Mid-sem	90 min	30		Open Book
Project/Term Paper&Seminar&		30	Continuous throughout the semester	
Comprehensive	3 hrs.	40		Open Book

6. **Chamber Consultation Hour:** To be announced in the class.

7. **Notices:** ME Notice Boards.

8. **Make–up:** Make-up will be given on **genuine** grounds only. Prior application should be

made for seeking the make-up examination.

Instructor-In-Charge
Dr. Sachin U Belgamwar