GOVERNMENT OF TAMILNADU

DIRECTORATE OF TECHNICAL EDUCATION, CHENNAI

STATE PROJECT COORDINATION UNIT

(Established under Canada India Institutional Cooperation Project)

CURRICULUM

Course Name	**MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)**
Course Code	ME/2020/006
Course Duration	40 Hours
Minimum Eligibility Criteria	ITI/10th/+2/Diploma/Graduates
Pre-requisites (if any)	Basic knowledge in Electronics, Sensors and Actuators
Course Objective s	Training module has been designed to provide the participants to • Understand the basic engineering concepts of MEMS. • Gain knowledge about the various Micro manufacturing Techniques • Learn the working principle of Micro sensors and Actuators • Realize the concepts of Micro fluidics and the applications of MEMS.
Course Outcomes	At the end of training, the participants will be able to • Explain MEMS Technology, present, future and challenges. • Explain micro sensors, micro –actuators, their types and applications. • Explain about fabrication processes for producing micro-sensors and actuators. • Apply Perform reliability, and failure analysis testing.
Expected Job Roles	Technician for micro sensors and actuators manufacturing industries.

TEACHING AND SCHEME OF EXAMINATION						
Course Code	Course Name	Hours		Assessment Marks		Duration of Examination
				Min	Max	
ME/2020/006	**MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)**	Theory	16	10	20	3 Hours
		Practical	24	40	80	
		Total	40	50	100	

ME/2020/006 – MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)

DETAILED SYLLABUS

Unit No.	Modules	No. of Hours	
		Theory	Practical
I	**OVERVIEW OF MEMS AND MICROSYSTEMS**	8 Hours	
1.1	MEMS and Micro system	03	
1.2	Typical MEMS and Microsystems Products		
1.3	Evolution of Micro fabrication		
1.4	Microsystems and Microelectronics		
1.5	Multidisciplinary Nature of Microsystems		
1.6	Miniaturization		
1.7	**Practical:** ➢ MEMS Fabrication process and Case Study ➢ MEMS Electronics ➢ MEMS Transducers ➢ Estimation of Resistance change in SOI Piezo-resistive Pressure Sensor		05
II	**WORKING PRINCIPLES OF MICROSYSTEMS**	**8 Hours**	
2.1	Micro sensors, Micro actuation	03	
2.2	MEMS with Micro actuators		
2.3	Micro accelerometers -Microfluidics.		
2.4	**Practical:** ➢ Demo on MEMS Sensors -actuators ➢ MEMS Characterization process - Mechanical and Case study (SEM/Nano Indenter /Bond Tester) ➢ MEMS Characterization process - Electrical and Case study		05
III	**ENGINEERING SCIENCE FOR MICROSYSTEMS DESIGN AND FABRICATION**	**7 Hours**	
3.1	Molecular Theory of Matter and Inter-molecular Forces	03	
3.2	Plasma Physics -Electrochemistry.		
3.3	**Practical:** ➢ MEMS Design Techniques and design tools ➢ Demo on MEMS Design Tools ➢ Characterization of Mems actuators		04
IV	**SCALING LAWS IN MINIATURIZATION**	**7 Hours**	
4.1	Scaling in Geometry -Scaling in Rigid-Body Dynamics	03	
4.2	Scaling in Electrostatic Forces		
4.3	Scaling in Fluid Mechanics		
4.4	Scaling in Heat Transfer		

4.5	**Practical:** ➢ MEMS Characterization process - Material and Case study ➢ MEMS Characterization process - X-ray Inspection ➢ MEMS + IC Co-simulation: Case Study		04
V	**OVERVIEW OF MICRO MANUFACTURING**	**10 Hours**	
5.1	Introduction, Bulk Micro manufacturing	04	
5.2	Surface Micromachining-The LIGA Process		
5.3	**Practical:** ➢ MEMS Fabrication for Bulk Micro manufacturing method used for wet etching or dry etching ➢ Liga technology to used high-aspect-ratio micromachining (HARM) ➢ MEMS Applications & Case study		06
	Total Theory and Practical hours	**16**	**24**
	Total hours	**40**	

HARDWARE REQUIREMENT

S. NO.	LIST OF TOOLS / EQUIPMENTS
1.	Microsensors
2.	Micro accelerometers
3.	Microfluidics
4.	Piezoelectric Sensors and Actuators
5.	Silicon etching tools
6.	Wafer grinders
7.	Planarization equipment
8.	Gas and chemical sensors
9.	Fuel cells
10.	Micro surgical tools
11.	Mechanical sensors

REFERENCE BOOKS

S. NO.	NAME OF THE BOOK	AUTHOR	PUBLISHER
1.	Micro fluidics and Bio mems application	Francis E.H. Tay and Choong	IEEE Press New York
2.	Micromechanics and MEMS	Trimmer William S	IEEE Press New York
3.	An introduction to Micro electro mechanical Systems Engineering	Maluf, Nadim	AR Tech house, Boston
4.	Micro sensors MEMS and Smart Devices	Julian W.Gardner, Vijay K.Varadan, Osama O. Awadel Karim	John Wi by sons Ltd.
5	Micro electro mechanical system (MEMS)	Dlip kumar Bhattacharya and Brajesh kumar kaushik	CENGAGE Learning India, first edition
6	Micro electro mechanical system (MEMS)	V.Thiyagarajan	Lakshmi Publications
7	MEMS & MICRO SYSTEM Design and Manufacture	Tai-Ran Hsu	McGraw Hill education

ASSESSMENT AND CERTIFICATION

S. No.	Criteria for Assessment
1.	A trainee will be assessed based on the performance in End Examination for Theory and Practical conducted internally in the Project Polytechnic College for a duration of 3 hours
2.	A trainee must have 75% of attendance to appear for End examination in Theory and Practical.
3.	The assessment for theory part will be based on the marks scored in the end examination on the knowledge bank of questions (1 word/objective type questions)
4.	The assessment for practical part will be based on the marks scored in the end examination conducted by the Project Polytechnic and assessed by the Examiners approved by Strategic Plan Implementation Committee (SPIC) of the project polytechnic.
5.	The passing criteria for successful completion of training is every trainee should score 50% of marks in theory and practical examination.
6.	On successful completion of training , Certificate will be issued to the participants by the Directorate of Technical Education through the Project Polytechnics.

END EXAMINATION

ALLOCATION OF MARKS

S.NO	Description	Max.Marks
1.	Theory Examination	20
2.	Practical Examination	
	a)Aim and Procedure	20
	b)Demonstration / Execution	25
	c) Result & Viva Voce	15
	d)Record	20
	Total Marks	**100**

THEORY MODEL QUESTION PAPER

ME/2020/006 - MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)

(Maximum Marks: 20)

(N.B: Answer any **Twenty** questions) **20x1= 20 Marks**

1. Define MEMS.
2. What is micro fabrication?
3. What are the Applications for MEMS?
4. Name any two materials used in the fabrication of MEMS.
5. Give any two applications of Microsystems.
6. What is actuator?
7. List any four types of micro sensors.
8. What are the applications of micro fluidic devices?
9. What is a transducer?
10. List the merits and demerits of capacitive sensors?
11. Give at least four distinct advantages of miniaturization of machines and devices.
12. What is an ion?
13. Write the Electrolysis chemical reaction.
14. Write the two principal applications of electrochemistry in micro fabrication.
15. What is miniaturization?
16. What are the types of scaling laws?
17. What are the scaling forces?
18. What are the modes of scaling heat transfer?
19. What are the two physical quantities involved in micro device design?
20. Give one advantage and one disadvantage of using surface micromachining.
21. What are the techniques used for thin film deposition?
22. Define DRIE.
23. Why is electroplating necessary in a LIGA process?
24. What are the major categories of micro machining techniques?
25. Define dry etching.