Techno India NJR Institute of Technology

Course File

Session 2021-22

Introduction to MEMS (6EC5-11)

Yogendra Singh Solanki
(Assistant Professor)
Department of ECE

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

III Year - VI Semester: B.Tech. (Electronics & Communication Engineering)

6EC5-11: Introduction to MEMS

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction and Historical Background.	1
3	Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law, Poisson effect, Linear Thermal Expansion, Bending; Energy methods, Overview of Finite Element Method, Modeling of Coupled Electromechanical Systems.	14
4	Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview: Case studies. Review of Basic MEMS fabrication modules: Oxidation, Deposition Techniques, Lithography (LIGA), and Etching.	14
5	Micromachining: Surface Micromachining, sacrificial layer processes, Stiction; Bulk Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding.	10
	Total	40

Course Overview:

This course is to inspire the students to expect to the trends in development and synthesizing of nano systems and measuring systems to nano scale. To expose the students to the evolution of Nano systems, to the various fabrication techniques. Also, to impart knowledge to the students about nano materials and various nano measurements techniques.

Course Outcomes:

CO.NO.	Cognitive Level	Course Outcome
1	Knowledge	Understand the characteristic techniques of micro system fabrication process
2	Comprehension	Describe the methods for processing MEMS and nano scale materials
3	Knowledge	Describe the evolution of Nano technology and its applications
4	Analysis	Analyze the various nano materials and measurements techniques and nano scale manufacturing

Prerequisites:

1. Fundamentals of electronics and electricals.
2. Knowledge of semiconductor Physics
3. Basic knowledge of kinematics of materials.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)											
CO. NO.	Domain Specific					Domain Independent						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1								
CO2	2	3		0								
CO3	2	1		1								
CO4	2	2	1	1								
1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High)												

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	**1**	**INTRODUCTION: Objective, scope and outcome of the course**
2	**2**	**INTRODUCTION AND HISTORICAL BACKGROUND.**
3	**3**	**MECHANICS OF SOLIDS IN MEMS/NEMS**
4	3	Different types of stresses
5	3	Different types of strain
6	3	Hookes's law
7	3	Poisson effect
8	3	Stress-strain curve
9	3	Linear Thermal Expansion
10	3	Bending
11	3	Static bending of thin plate
12	3	Bending of rectangular plate
13	3	Bending of circular plate
14	3	Energy methods
15	3	Overview of Finite Element Method
16	3	Modeling of Coupled Electromechanical Systems
17	**4**	**SCALING EFFECTS**
18	4	Scaling Effects
19	4	Different types of Micro/Nano Sensors
20	4	Different types of Micro/Nano Sensors
21	4	Different types of Micro/Nano Actuators
22	4	Different types of Micro/Nano Actuators
23	4	Different types of actuations
24	4	Review of Basic MEMS fabrication modules
25	4	Oxidation
26	4	Deposition Techniques: CVD
27	4	Deposition Techniques: PVD
28	4	Epitaxy
29	4	Lithography (LIGA)
30	4	Etching
31	**5**	**MICROMACHINING**
32	5	Introduction to Bulk Micromachining
33	5	Different steps used in bulk micromachining
34	5	Isotropic Etching
35	5	Anisotropic Etching
36	5	Introduction to surface Micromachining
37	5	Different steps used in surface micromachining
38	5	Sacrificial layer processes
39	5	Comparison in different micromachining methods
40	5	Wafer Bonding

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

TEXT/REFERENCE BOOKS

1. Introduction to Nanotechnology, Risal Singh, Shipra Mital Gupta, Oxford University press.
2. Nano Essentials, T Pradeep, Mc Graw Hill, (2008).
3. Nanotechnology-Enabled Sensors, Kourosh Kalantar-zadehand Benjamin Fry, Springer, (2007).
4. Fundamental of Nanoelectronics, George W. Hanson, Pearson 2009
5. Principal of Nanotechnology, G. A. Mansoori, Wiley 2005
6. MEMS & Microsystems, Design and Manufacture, Tai-Ran HSU, TMH 2013

Teaching and Learning resources:

MOOC (NPTEL): - https://nptel.ac.in/courses/112/108/112108092/

Assessment Methodology:

1. Two Midterm exams where student have to showcase subjective learning.
2. Final Exam (subjective paper) at the end of the semester.

8E 8023

Roll No. _____ [Total No. of Pages : 2

8E 8023

B.Tech. VIII-Semester (Main & Back) Examination, April-2019
Electronic Instrumentation & Control Engg.
8EI4.2A MEMS and Nanotechnology
(Common with EC, EI)

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 26

Instructions to Candidates:

*Attempt any **Five questions**, selecting **One question** from **each unit.** All Questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly Units of quantities used/calculated must be stated clearly).*

Unit - I

1. a) Explain the top down and bottom up approach of nanotechnology with suitable diagrams. **(8)**

   b) Give the difference between metals, insulator and semiconductors with band structures. **(8)**

(OR)

1. a) What is the effect of size and dimensions on nanostructured crystal? Explain Quantum dot, wire and Quantum well. **(10)**

   b) Briefly explain the graphene and CNT. **(6)**

Unit - II

2. a) Briefly explain the physical vapour deposition techniques of thin films. **(8)**

   b) Classify the different CVD techniques of thin film deposition with their process parameters and explain any one. **(8)**

(OR)

2. a) Explain the different steps in lithographic process of pattern writing with suitable diagrams. **(8)**

   b) Compare the x-ray and e-beam litho process. **(8)**

Unit - III

3. a) Discuss the XRD technique of characterization of thin films with D-bye Scherrer's formula. **(8)**

   b) Compare Raman spectroscopy with NMR spectroscopy technique. **(8)**

(OR)

3. Write the short notes on any **Two :** **(2×8)**
   i) SEM
   ii) AFM
   iii) XPS
   iv) DLS

Unit - IV

4. a) What are Nano medicines? Which approach has been used for developing nano medicines? **(8)**

   b) Explain the application of nano technology in sensing with suitable examples. **(8)**

(OR)

4. a) Discuss the electrical, mechanical and optical properties of nano particles. **(12)**

   b) What do you mean by nano biology? **(4)**

Unit - V

5. a) Discuss the case study of pressure sensor with packaging. **(8)**

   b) Explain various types of MEMS packages. **(8)**

(OR)

5. a) Explain the applications of MEMS. **(8)**

   b) Discuss the following in brief.
      i) Wafer.
      ii) Substrate and active substrate. **(8)**
