INTRODUCTION TO MEMS
(AEIE 4111)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Sputtering is a process of
(a) Physical Vapour Deposition (b) Dry etching
(c) Chemical Vapour Deposition (d) Doping.

(ii) According to Scaling in Geometry "an elephant can never fly as easily as a dragonfly", as the surface to volume ratio (S/V) of dragonfly is
(a) 1/10 (b) 1/100 (c) 1/1000 (d) 1/10000.

(iii) In smart phone, the most commonly used touch screen sensor is
(a) MEMS gyroscope (b) MEMS accelerometer
(c) MEMS capacitive sensor (d) MEMS inductive sensor.

(iv) Spin coating is a form of
(a) Etching (b) Chemical Vapour Deposition
(c) Ionisation (d) Physical Vapour Deposition.

(v) The silicon compound preferred as pizeo-electric material in MEMS sensor is
(a) Silicon dioxide (SiO_2) (b) Silicon carbide (SiC)
(c) Silicon nitride (Si_3N_4) (d) Polysilicon.

(vi) The etching process preferred for the fabrication of comb drive is
(a) DRIE (b) Wet etching
(c) Plasma etching (d) Isotropic etching.

(vii) The problem of "Stiction" is mostly seen in finished micro-structures made by
(a) bulk micromachining (b) surface micromachining
(c) LIGA (d) LASER microfabrication.

(viii) The most common Chemical Vapour Deposition (CVD) process is
(a) LPCVD (b) APCVD (c) PECVD (d) Sputtering.

(ix) In lithography, more clear edge definitions is achieved by
(a) positive resist (b) negative resist (c) wet etching (d) plasma etching.

(x) The high aspect ratio is achieved by
(a) bulk micromachining
(b) surface micro-machining
(c) ion implantation
(d) LIGA.

Group- B

2. (a) When and in which institute did Richard Feynman give a milestone presentation on micro-electromotor? When was the first LIGA process introduced? [(CO1)(Remember/LOCQ)]
(b) List the popular MEMS structures. [(CO4)(Analyze/IOCQ)]
(c) Assess the steps related to design process flow of MEMS structures. [(CO1)(Evaluate/HOCQ)]

(2 + 2)+ 5 + 3 = 12

3. (a) Describe the reasons behind miniaturization. [(CO1)Remember/LOCQ]
(b) Discuss the importance of scaling laws in miniaturization. [(CO2)Evaluate/HOCQ]
(c) List the pros and cons of capacitive type MEMS pressure sensor over piezo resistive type. [(CO4)Apply/IOCQ]

4 + 3 + 5 = 12

Group - C

4. (a) Describe the steps involved in microfabrication technique with a suitable block diagram. [(CO4)(Remember/LOCQ)]
(b) Compare MEMS fabrication techniques with conventional IC fabrication technology. [(CO2) (Analyze/IOCQ)]
(c) Explain the importance of photoresistive material in photolithography. [(CO1)(Evaluate/HOCQ)]

4 + 5 + 3 = 12

5. (a) Identify different types of Chemical Vapour Deposition (CVD) techniques used in micro-fabrication process. [(CO4)(Apply/IOCQ)]
(b) Explain the process of doping in semiconductors. [(CO2)(Evaluate/HOCQ)]
(c) What are the advantages of dry etching over wet etching? [(CO3)(Remember/LOCQ)]

5 + 3 + (2 + 2) = 12

Group – D

6. (a) Justify the role of Silicon as an ideal substrate material for MEMS fabrication. [(CO4)(Evaluate/HOCQ)]
(b) How is Si_2O manufactured? [(CO2)(Understand/LOCQ)]
(c) Indentify the key chemical reactions involved in this process. [(CO1)(Analyze/IOCQ)]

3 + 4 + 5 = 12

7. (a) What is wet etching? What are the limitations of wet etching? [(CO4)(Remember/LOCQ)]

(b) Make a distinction between deep reactive ion etching from plasma etching. [(CO2)(Analyze/IOCQ)]

(c) Evaluate the pros and cons of bulk micromachining. [(CO1)(Evaluate/HOCQ)]

4 + 5 + 3 = 12

Group - E

8. (a) List the basic input information required for Finite element based analysis. [(CO6)(Remember/LOCQ)]

(b) Examine the possible sources for intrinsic stresses in thermomechanical stress analysis. [(CO5)(Analyze/IOCQ)]

(c) Define the modes which are to be considered for Interfacial fracture mechanical analysis. [(CO6)(Remember/LOCQ)]

4 + 5 + 3 = 12

9. (a) Identify 'Death' and 'Birth' elements in microfabrication simulation method using FEM. [(CO5)(Analyze/IOCQ)]

(b) Discuss the dynamic analysis required in MEMS structure. [(CO5)(Remember/LOCQ)]

(c) List at least three softwares those are based on FEM codes. [(CO6)(Analyze/IOCQ)]

4 + 5 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.50	43.75	18.75

Course Outcome (CO):

After the completion of the course students will be able to:

1. Appreciate the underlying working principles of MEMS and NEMS devices.
2. Identify the fabrication procedure like deposition, lithography and etching.
3. Understand the issues related to deposition and etching
4. Learn different types of micro-manufacturing techniques
5. Acquire knowledge regarding mechanics of micro and nano devices.
6. Design and model of MEMS devices.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question