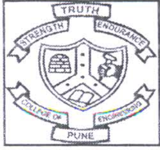

COLLEGE OF ENGINEERING, PUNE

(An Autonomous Institute of Government of Maharashtra.)
SHIVAJI NAGAR, PUNE - 411 005

END Semester Examination

(DE) PE 14004- Micro-Electro Mechanical Systems TH

Course: B.Tech | Branch: Production Engineering (Sandwich)

Semester: Sem VII

Year: 2014-2015 | Max.Marks:60

Duration: 3 Hours | Time:- 2 to 5 p.m. | **Date:2-12-2014**

Instructions: | **MIS No.** ☐☐☐☐☐☐☐☐☐

1. Figures to the right indicate the full marks.
2. Mobile phones and programmable calculators are strictly prohibited.
3. Writing anything on question paper is not allowed.
4. Exchange/Sharing of anything like stationery, calculator is not allowed.
5. Assume suitable data if necessary.
6. Write your MIS Number on Question Paper
7. Attempt any SIX questions.

Q1. Give atleast five distinct advantages of miniaturization of machines and devices. (5)

Q2. Explain the importance of piezoelectric and shape memory materials in MEMS devices with a suitable example of each. (5)

Q3. Describe DRIE process. How can this process achieve virtually perfect virtual etching? (5)

Q4. Briefly explain the fabrication steps in LIGA process. What are the major advantages of this process? What is SLIGA? (5)

Q5. A CVD process involves a reactant being diluted to 1.8 percent in the carrier oxygen gas at 490°C. Find the number of molecules in cubic meter volume of the carrier gas. Pressure variation in the process is negligible. The CVD process is carried out in a horizontal reactor. Determine the following: (10)

i) Density of carrier gas

ii) Reynolds number of the gas flow

iii) Thickness of the boundary layer over the substrate surface

iv) Surface reaction rate

v) Deposition rate

OR

A silicon substrate is subjected to diffusion of boron dopant at 1000°C, 900°C and 800°C with a dose $10^{12}/cm^2$. Find the expression for estimating the concentration of dopant in the substrate. Also find the concentration at 0.25 μm beneath the surface after 1 hour into the diffusion process. (10)

What observations will you make for this exercise?

Q6. a. Explain the construction and working of electrostatically actuated micropump. State the applications of such a device. (10)

Q7. State the need of Microsystems packaging. Explain three level Microsystems packaging with a neat sketch. (10)

Q8. What are scaling laws and explain any of them. (5)

Q9. Write short notes on the following (Any **TWO**): (5)

a. Design and fabrication of microgripper

b. Ion implantation

c. Photoresist types and materials

Table 1

Ion implantation of common dopants in silicon

Ion	**Range R_p, nm**	**Straggle, ΔR_p, nm**
	At 30 keV energy level	
Boron	106.5	39
Phosphorus	42	19.5
Arsenic	23.3	9.0
	At 100 keV energy level	
Boron	307	69
Phosphorus	135	53.5
Arsenic	67.8	26.1

Table 2

Dopants	**Constant, a**	**Constant, b**
Boron	-19.9820	13.1109
Arsenic	-26.8404	17.2250
Phosphorus($N_s=10^{21}/cm^3$)	-15.8456	11.1168
Phosphorus($N_s=10^{19}/cm^3$)	-20.4278	13.6430