

MANIPAL INSTITUTE OF TECHNOLOGY Manipal University



SIXTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION MAY/JUNE 2016 SUBJECT: MEMS TECHNOLOGY (OPEN ELECTIVE) (ECE -348)

TIME: 3 HOURS

MAX. MARKS: 50

Instructions to candidates

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitably assumed.
- 1A. Describe diffraction phenomenon. Bring out the differences between Fresnel and Fraunhofer diffraction
- 1B. A silicon wafer has been etched through square window opening of size 10umx10um in the oxide layer. Draw cross section profiles and mark all dimensions of etched silicon for the following cases.
 - a) Isotropic chemical etchant ,wafer is <100> silicon, etch depth is 5um
 - b) Etchant is KOH solution, wafer is <100> silicon, etch depth is 5um.
- 1C. A plane intercepts the X,Y and Z axis at 2,3,4 respectively. Obtain an equation for the plane. Write down the miller indices for this plane.

(5+3+2)

- 2A. Explain the different process steps involved in the surface micromachining technology for realizing a polysilicon cantilever beam.
- 2B. The length, width and thickness of a polysilicon cantilever beam is 200um, 30um and 2um respectively:
 - a) If the density of polysilicon is 2200 kg/m³ and measured resonance frequency is 68kHz, determine the young's modulus of the polysilicon
 - b) This beam is used for detection of deposited mass by measuring the resonance frequency of the beam before and after deposition of mass. The least count of frequency measurement is 1 KHz. What is the least count in terms of mass?
 - c) Assume that on realizing the beam, the length and thickness of the beam reduces by 10%, by what percentage the resonance frequency changes?
- 2C. If a wafer goes through an ideal isotropic wet etching process with an etching rate of 1.6um/ min for 22 seconds, what will the vertical depth of the etch be in the silicon wafer.? What will be the width of etch.

(5+3+2)

- 3A. Explain the construction of ISFET with neat sketch and mention its application for sensing devices.
- 3B. What is LIGA process? Explain the steps involved in fabricating micro parts by means of the LIGA Process.
- 3C. Explain any one nonsilicon technology for manufacturing MEMS

(5+3+2)

- 4A. What is phase shifter? Explain the principle of operation of a switched line phase shifter. What are the advantages of MEMS phase shifters over GaAs MMIC Phase shifters?
- 4B. Design a switched line phase shifter with a 22.5 degree phase shift at 4GHz, on a substrate with a dielectric constant of 9.9.
- 4C. A proximity aligner is used to expose 1um aperture .The gap is 25um and the separation between the mask and g line source is 0.5m, what is the condition of diffraction? Assume exposure wavelength of gline source 436 nm

(5+3+2)

- 5A. Explain the working principle of diaphragm based micro pump and model it to express the pumping speed at the atmospheric pressure.
- 5B. What are RF MEMS ? Mention the frequency range of operation. Compare MEMS based devices with GaAs FET's and other PIN diodes.
- 5C. What are the possible wafer bonding techniques?

(5+3+2)

- 6A What are surface Plasmon's? Explain with neat diagram how surface Plasmon resonance technique used for sensing application.
- 6B How does a MEMS gyroscope work? Explain coriolis force with an example of bicycle.
- 6C The camera of spy satellite orbiting at 200km has a diameter of 25cm. What is the smallest distance this camera can resolve on the surface of the earth? Assume a wavelength of 500nm.

(5+3+2)