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MANIPAL INSTITUTE OF TECHNOLOGY Manipal University

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

## TIME: 3 HOURS

MAX. MARKS: 50

## Instructions to candidates

- Answer ANY FIVE questions.Missing data may be suitably assumed.
- With neat diagram explain LIGA technology. Explain the steps involved in fabrication 1A. microstructures. Find the Reynolds number associated with two cases: i) a person swimming in a swimming pool 1B. filled with molasses with a kinematic viscosity of 10,000 centistrokes and 1.8 m and swims at a woeful. And ii) a 1.8 mm long tadeploe moving in water ( with kinematic viscosity of 1 centistroke at a velocity of 1cm/s. 1C. What is the resonance frequency for a silicon cantilever beam 1000 um long, 100 um wide and 3 um thick? The density of silicon is 2.3 g/cm3.Assume E=190GPa. (5+3+2)With neat diagrams explain any two Non optical techniques. What are the advantages compared to 2A. traditional photolithography What is Stiction in MEMS ? Explain any two techniques to overcome stiction. 2B. 2C. A 30 um thick membrane is needed for a pressure sensor application. Calculate the size of the mask opening W needed for the v-groove if the full wafer thickness is 600 um. (5+3+2)Explain the working principle of Biochip? What are the pros and cons of human Biochip 3A. Implantation? What are miller indices? Draw a <110> and <111> plane inside a cubic unit cell. Obtain the Miller 3B. indices of the plane which intercepts at a ,b/2,3c in a simple cubic unit cell. 3C. What are the purposes of having wafer, sacrificial material and structural material in typical MEMS fabrication? (5+3+2)Explain the principle of operation of a switched line phase shifter. What are the advantages of 4A. MEMS phase shifters over GaAs MMIC Phase shifters? Design a switched line phase shifter with a  $23.5^{\circ}$  phase shift at 6 Ghz, on a substrate with a 4B. dielectric constant of 9.9. A proximity aligner is used to expose 1um aperture .The gap is 25um and the separation between 4C. 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 proximity and projection printing mechanisms used to obtain high resolution of contact printing without the defects.
5B.	If an exposure tool has numerical aperture of 0.25 and an exposure wavelength of 428nm and spatial coherence S of 0.4, what is the minimum feature size that this tool can resolve .What is depth of focus? If this source were replaced with i-line source (wavelength=365nm), how would these number change .Comment on your answer.
5C.	Design a mask for a 15um long ,5um deep v-groove trench using EDP ( anisotropic etchant) .how wide should the mask window be? If EDP has a Si <100> plane etch rate of 1um/min ,how long should the etchant be applied.
	(5+3+2)
6A.	What are surface Plasmon's? Explain with neat diagram how surface Plasmon resonance technique used for sensing application.
6B.	Write short notes on the following mechanical MEMS elements:
	a) Micro cantilever
	b) Diaphragm
6C.	With neat diagram explain any two wafer bonding techniques in MEMS.
	(5+3+2)