Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VII SEMESTER B.TECH (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: MICRO ELECTRO MECHANICAL SYSTEM [MME 423]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitably assumed.

1A. Sketch and explain the working principle of micro-manufacturing process used to manufacture metallic microstructures. **4**

1B. What are the benefits of miniaturization? **2**

1C. Suggest a method to produce pure silicon crystal. With the help of neat sketch explain its working principal in detail. **4**

2A. Explain the different levels of packaging in microsystem. **3**

2B. Justify the use of electrostatic force compared to Electromagnetic force in micro actuation devices. Derive the equation for the same. **3**

2C. Sketch and explain working of micro pressure sensor using a vibrating beam signal transducer? Explain why the change of the state of the stress in a silicon diaphragm results in a change of its resonant frequency? **4**

3A. Explain different types of chemical sensors. **4**

3B. Estimate the voltage output of the microthermopile shown in Figure 1, if "J" type (50.37μV/°C) wire materials are used with the hot junction temperature at 145° C while the cold junction is maintained at 0° C. Determine the voltage output, If microthermopile are replaced by "K" type (39.48 μV/°C) thermocouple for the same operating temperature. **2**

3C. One Volt is applied to the printer head pumping mechanism consisting of Rochelle salt as piezoelectric crystal (d= 350×10^{-12} m/V) to pump the ink on the paper. Determine the resolution of the printer interms of dots per inch. The ink droplet is assumed to produce a dot with a film thickness of 700 nm on the paper. The geometry and dimension of the printer head is illustrated in Figure 2. Assume that the ink droplet takes a shape of a sphere and the inkwell is always re-filled after ejection. **4**

4A. Differentiate between positive and negative photoresist. With the help of schematic arrangement explain the process used to apply photoresist onto the surface of substrates. **4**

4B.	Derive scaling vectors for acceleration, time, power density based on trimmer force scaling vector.	**2**
4C.	Illustrate the technique used to dope the semiconductor at low temperature. Draw the schematic arrangement of the process and the distribution of dopant in the substrate material.	**4**
5A.	Differentiate dry etching and wet etching in bulk micromanufacturing.	**3**
5B.	List and compare three types of CVD process with respect to the process parameters, advantage, disadvantage and application.	**4**
5C.	Describe the applications of Langmuir-Blodgett (LB) film.	**3**
6A.	Describe any three types of surface bonding techniques used in microsystem.	**3**
6B.	With the help of neat sketch explain how a micro cantilever beam is produced?	**4**
6C.	Determine the minimum thickness of the rectangular diaphragm of a micro pressure sensor made of Silicon with the conditions: Plane area = 32 X 10^4 μm^2; a/b ratio = 2; α = 0.0277; β = 0.4974; Applied pressure = 15 MPa; Yield strength of silicon = 7000 MPa; Young's modulus = 190 GPa and Poisson's ratio = 0.25. Also find maximum stress if rectangular diaphragm is replaced with i) square, ii) circular diaphragm of same plane area.	**3**

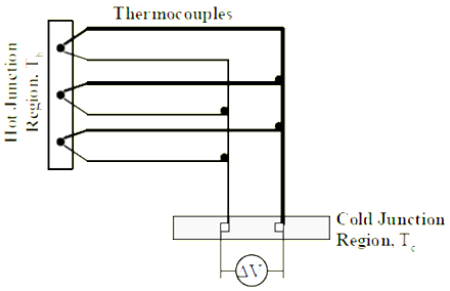

Figure 1.

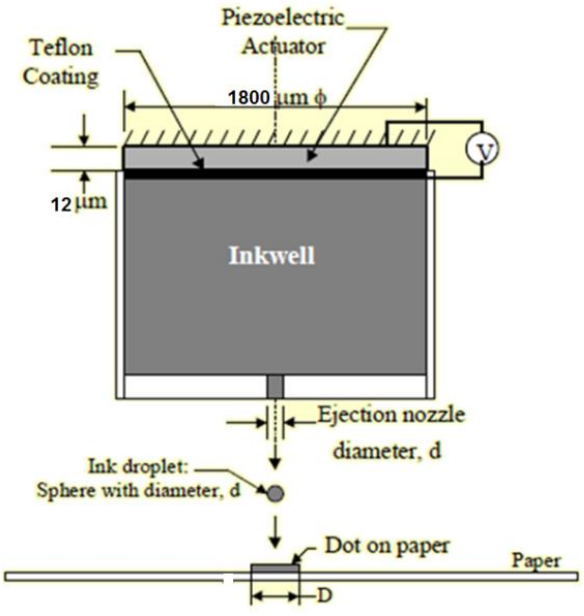

Figure 2.