Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	MICROELECTROMECHANICAL SYSTEMS
COURSE CODE	:	BWC 31103
PROGRAMME	:	3 BWC
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Write short notes on the following,

(i) Thermistors
(ii) Thermodevices
(iii) Thermocouple

(9 marks)

(b) According to a micromachined thermocouple probe,

(i) State how the probe tip can be used for 3D topographic applications
(ii) Draw the equivalent circuit of the thermocouple probe and define the terms
(iii) List the primary process sequences of fabricating a typical thermocouple probe

(11 marks)

Q2 (a) Discuss in detail how a spherical microlens is fabricated.

(12 marks)

(b) It is required to fabricate a ball lens array where the specified cap diameter of each identical ball lens is 2.5 micron. The ratio of cut cap diameter to ball lens diameter is 0.5. Calculate,

(i) The height up to which the lens cannot be used
(ii) The volume of each lens after the heat treatment
(iii) How much polymer would be needed for a 16×16 configuration

(8 marks)

Q3 (a) Clearly discuss the principle of operation of the following Microelectromechanical Systems (MEMS) products.

(i) Digital Micromirror Device (DMD)
(ii) Grating Light Valve (GLV)

(12 marks)

(b) From the simplified practical formula for the deflection as presented below

$$\delta(V) = \frac{h}{3}\left[1 - \left\{1 - \left(\frac{V}{V_s}\right)^w\right\}^{2/3w}\right]$$

calculate $\delta(V)$ when $0 \leq V < V_s$ and sketch the relationship between the applied voltage, V versus deflection, δ in electromechanical model of the GLV. The following assumption and parameters are given:

Saturation voltage, $V_s = (4kh^3/27\beta)^{1/2}$
Fitting parameter, w = 1.8
Hookes constant, k = 4000 N/m
Gap height, h = 100 μm
β is a parameter that depends on the ribbon area and the effective permittivity $= 23.7 \times 10^{-12}$ units

(8 marks)

Q4 (a) Explain the following thin film development processes.

(i) Low Pressure Chemical Vapor Deposition (LPCVD)
(ii) Sputtering

(14 marks)

(b) Find out the desired viscosity to density ratio of a photoresist solution to be prepared for the spin coating by using a vacuum chunk. The allowed time of rotation of the chunk within a production process is 2 minutes and the desired height (h) of photoresist is 50 microns. The rotor rotates at 6000 rpm. Assume that the original height, h_o is 500 microns. The time of spin, t (seconds) formula is given as

$$t = \frac{3\mu}{4\rho w^2}\left(\frac{1}{h^2} - \frac{1}{h_o^2}\right)$$

where w is in radians per second.

(6 marks)

Q5 (a) State seven (7) important elements and their function in micro-optical technology .
(7 marks)

(b) According to the basic modeling elements in mechanical system (spring concept),

(i) If the force to stretch a cantilever is given as $F = (100\ \text{N/m})\ x$, then what is the potential energy of the cantilever if it is stretched 5 microns from rest?

(ii) What is the elastic potential energy of the cantilever at the strecthed position of 40 microns in distance while it takes a force of 20 milinewtons to hold the stretched cantilever?

(7 marks)

(c) Consider the RLC electrical system, in which all the basic modeling elements are connected in series. Derive the dynamics of the system if the applied voltage is a time-varying voltage as shown below

$$\frac{d^2i}{dt^2} + 2\alpha\frac{di}{dt} + \omega_o^2 i(t) = \frac{1}{L}\frac{dv}{dt}$$

(6 marks)

- **END OF QUESTION** -