Second Semester Examination
2017/2018 Academic Session

May/June 2018

EEM 354 – Manufacturing Management and Technology
(Pengurusan Dan Teknologi Pembuatan)

Duration : 3 hours
(Masa : 3 jam)

Please ensure that this examination paper consists of **NINE (9)** pages and **ONE (1)** page of printed appendices material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN (9)** muka surat dan **SATU (1)** muka surat lampiran yang bercetak sebelum anda memulakan peperiksaan ini.]*

Instructions: This question paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry the same marks.

[***Arahan:*** *Kertas soalan ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan. Semua soalan membawa jumlah markah yang sama.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

1. (a) Explain the process of producing single crystal silicon ingot.
Terangkan proses penghasilan jongkong kristal tunggal silicon.

(15 marks/*markah*)

(b) Write down the all the chemical reactions for,
Tuliskan semua reaksi kimia bagi,

(i) The production of Electronic Grade Silicon
Pengeluaran Silikon Gred Elektronik

(5 marks/*markah*)

(ii) Chemical Vapour Deposition of Silicon Nitrate
Endapan Wap Kimia bagi Silikon Nitrida

(5 marks/*markah*)

(c) A single crystal ingot of silicon is grown by Czochralski process to an average diameter of 300 mm with length=1400 mm. The seed and tang ends are removed, which reduces the length to 1100 mm. The diameter is ground to 290 mm. The ingot is then sliced into wafer thickness=0.50 mm, using an abrasive saw blade whose thickness=0.30 mm. Assuming that the seed and tang portions cut off the ends of the starting boule were conical in shape, determine:

Satu jongkong kristal tunggal dibina melalui proses Czoshralski kepada diameter purata 300 mm dan panjang 1400 mm. Kedua hujung dibuang menyebabkan panjang dikurangkan kepada 1100 mm. Diameter dikisar kepada 290 mm. Jongkong dihiris kepada ketebalan 0.50 mm menggunakan bilah gergaji lelasan yang berketebalan 0.30 mm. Dengan menganggap kedua-dua hujung awal jongkong berbentuk kon, tentukan:

(i) The original volume of the ingot
Isipadu asal jongkong

(ii) How many wafers can be cut from it
Berapa bilangan wafer yang diperolehi

(iii) The volumetric proportion of silicon in the starting boule that is wasted during processing.
Kadar isipadu silicon dalam jongkong asal yang dibazirkan sepanjang proses.

Given: The volume of a cone = $\pi r^2 \frac{h}{3}$
Diberikan: Isipadu satu kon = $\pi r^2 \frac{h}{3}$

(30 marks/*markah*)

(d) (i) Explain the fabrication processes of an accelerometer based on Figure 1.
Terangkan proses-proses fabrikasi satu meter-pecutan berdasarkan Rajah 1.

(25 marks/*markah*)

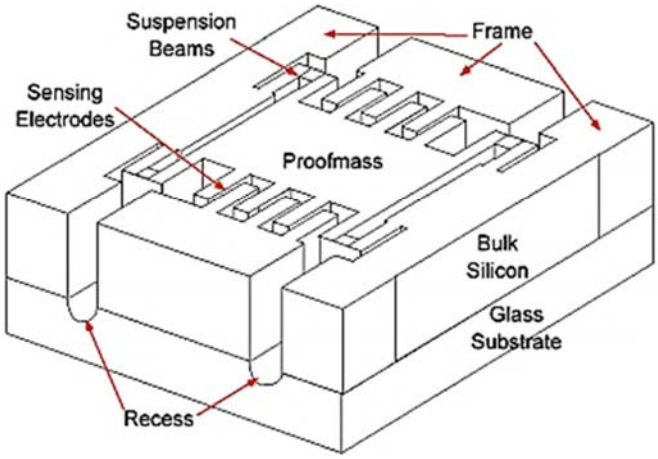

Figure 1

Rajah 1

(ii) Calculate the value of capacitance at the sensing electrode for Figure 1 when the acceleration is zero. Use the following data.

Kira nilai kapasitan pada elektrod pengesan bagi Rajah 1 apabila pecutan adalah kosong. Guna data berikut.

Given: h_{comb}=10 μm, g_f=3 μm, L_f =80 μm

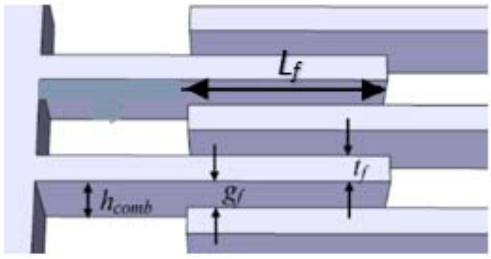

Figure 2

Rajah 2

(10 marks/*markah)*

(iii) Discuss on the changes of the capacitance value based on (a) doubling the number of fingers (b) reducing g_f by 50%.
Bincang perubahan nilai kapasitan berdasarkan (a) bilangan jejari digandakan (b) pengurangan nilai g_f sebanyak 50%.

(10 marks/*markah*)

2. (a) (i) Explain the processes of the fabrication of a MOSFET shown in Figure 3. Your explanation should be based on the cross sectional view of section 1-1.

Terangkan proses-proses yang terlibat dalam pembikinan satu MOSFET seperti yang ditunjukkan oleh Rajah 3. Penerangan anda perlu berdasarkan pandangan keratan rentas bagi bahagian 1-1.

(30 marks/*markah*)

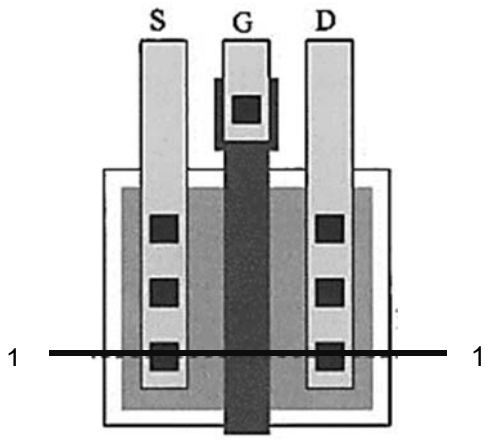

Figure 3

Rajah 3

(ii) Explain the differences of forming a polysilicon layer using negative resist and positive resist. Your explanation should be based on Figure 3.

Terangkan perbezaan bagi pembentukan lapisan polisilikon menggunakan rintang negatif dan rintang positif. Penerangan anda mestilah berdasarkan Rajah 3.

(20 marks/*markah*)

(b) Prototype of a tube with a square cross section is to be fabricated using Stereolithography. Given that 10 seconds are required to lower the platform, the thickness of each layer is 0.40 mm, the diameter of laser beam at the surface is 0.25 mm and the speed of the laser beam at the surface is 500 mm/s The followings are the dimensions of the tube:

Outside diameter =100 mm

Inside diameter = 90 mm

Height = 80 mm

Contoh sulung bagi sebuah tiub yang mempunyai keratan rentas segiempat sama akan dibina menggunakan Stereolithografi. Diberikan 10 saat diperlukan untuk mengurangkan ketinggian pelantar, ketebalan setiap lapisan ialah 0.40 mm, diameter sinaran laser pada permukaan ialah 0.25 mm dan halaju sinaran laser pada permukaan ialah 500 mm/s.

Berikut adalah dimensi tiub tersebut:

Diameter luar	=100 mm
Diameter dalam	= 90 mm
Tinggi	= 80 mm

(i) Draw the orientation of the finished prototype on the platform. Explain the choice of the orientation.

Lukis orentasi bagi contoh sulung yang siap di atas pelantar. Terangkan pilihan orientasi tersebut.

(ii) Calculate the time required to build the prototype.

Kira masa yang diperlukan untuk membina contoh sulung tersebut.

(30 marks/*markah*)

(c) Explain the differences between Stereolithography and Fused Deposition Manufacturing in Rapid Prototyping.

Terangkan perbezaan antara Stereolitografi dan Pembuatan Lakuran Mendapan dalam Contoh Sulungan Pantas.

(20 marks/*markah*)

3. (a) Define the term Manufacturing System.

Takrifkan Sistem Pembuatan.

(20 marks/*markah*)

(b) Name two departments that are typically classified as manufacturing support departments, and elaborate of their functions.

Namakan dua jabatan yang biasanya diklasifikasikan sebagai jabatan sokongan pembuatan dan jelaskan fungsi jabatan tersebut.

(40 marks/*markah*)

(c) What are the differences among primary, secondary, and tertiary industries? Give an example of each category.

Apakah perbezaan di antara industri rendah, menengah, dan tertiari? Berikan satu contoh bagi setiap kategori.

(40 marks/*markah*)

4. (a) What are benefits usually cited for Numerical Control compared to manual alternative methods?

Apakah faedah yang biasanya dinamakan Kawalan Berangka berbanding kaedah alternatif manual?

(20 marks/*markah*)

(b) Describe **THREE** basic types of automated systems used in manufacturing.

*Terangkan **TIGA** jenis asas sistem automatik yang digunakan dalam pembuatan*.

(20 marks/*markah*)

(c) Given that annual demand for a product is 20,000 units, cost per unit = RM 6.00, holding cost rate = 2.5%/months, changeover (setup) time between products averages 2.0 hours, and downtime cost during changeover = RM 200/hours, determine

Diberi bahawa permintaan tahunan bagi produk yang adalah 20,000 unit, kos per unit = RM 6.00, kadar kos pegangan= 2.5% / bulan, purata pertukaran (setup) masa antara produk 2.0 jam, dan kos downtime semasa pertukaran = RM 200/jam, tentukan

(i) economic order quantity
ekonomi pesanan kuantiti

(30 marks/*markah*)

(ii) total inventory costs for this situation

jumlah kos inventori bagi keadaan ini

(30 marks/*markah*)

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APPENDIX
LAMPIRAN

$$\varepsilon_0 = 8.854 \times 10^{-12} \frac{F}{m}$$

$$E = \frac{1}{2} CV^2$$

$$F = -\frac{\partial E}{\partial x}$$

$$C = k\varepsilon_0 \frac{A}{d}$$