Second Semester Examination
2018/2019 Academic Session

June 2019

EEM354 – Manufacturing Management And Technology
(Pengurusan Dan Teknologi Pembuatan)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of <u>EIGHT</u> (8) pages and <u>ONE</u> (1) appendix of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi <u>LAPAN</u> (8) muka surat dan <u>SATU</u> (1) lampiran yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions : This paper consists of **FOUR (4)** questions. Answer **FOUR (4)** questions.

*[__Arahan__ : Kertas ini mengandungi **EMPAT (4)** soalan. Jawab **EMPAT (4)** soalan.]*

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

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

...2/-

1.   (a)   (i)   Draw the schematic circuit for the layout in Figure 1.

Lukis litar skematik bagi susun atur dalam

(10 marks/*markah*)

(ii)   Explain in detail the processes of the fabrication of a MOSFET where the layout is shown in Figure 1. Your explanation and sketches should be based on the cross sectional view of section 1-1.

Terangkan proses-proses yang terlibat dalam pembikinan satu MOSFET seperti yang ditunjukkan susun atur dalam Rajah 1. Penerangan dan lakaran anda perlu berdasarkan pandangan keratan rentas bagi bahagian 1-1.
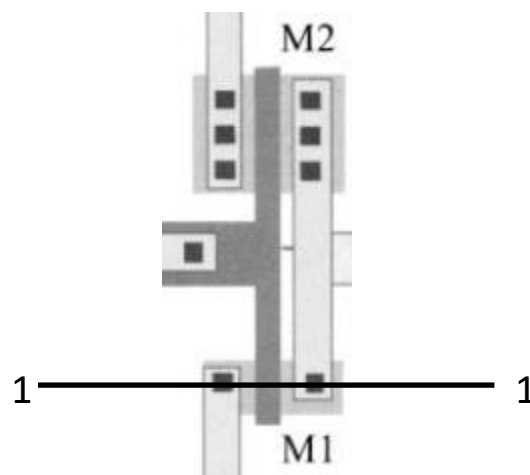
(30 marks/*markah*)

Figure 1

Rajah 1

(b)   Explain the process of producing single crystal silicon ingot using Czochralski process with the starting raw material, sand.

Terangkan tentang proses penghasilan jongkong kristal tunggal silicon menggunakan proses Czochralski bermula dengan pasir sebagai bahan mentah.

(15 marks/*markah*)

...3/-

(c)   Explain and write down all the chemical reactions for

Terangkan dan tuliskan semua persamaan kimia bagi

      (i)   Oxidation of silicon

             Pengoksidaan silikon

(15 markah/*markah*)

      (ii)   Chemical Vapour Deposition of Silicon Nitrate

             Endapan Wap Kimia bagi Silikon Nitrida

(10 marks/*markah*)

(d)   A single crystal boule 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 a wire-cutter whose thickness=0.30 mm. The wafers are used to fabricate integrated circuit with the dimension of 20 mm on a side. Each IC has a market value of RM100. 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 pemotong-wayar yang berketebalan 0.30 mm. Wafer digunakan untuk membina litar terkamil dengan dimensi 20 mm pada setiap sisi. Setiap IC mempunyai harga pasaran RM100. Dengan menganggap kedua-dua hujung awal jongkong berbentuk kon. Tentukan:

      (i)   The original volume of the boule

             Isipadu asal jongkong

(5 marks/*markah*)

      (ii)   How many wafers are cut from it

             Berapa bilangan wafer yang diperolehi

(5 marks/*markah*)

...4/-

       (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.

(5 marks/*markah*)

       (iv)   Estimate the value of all IC chips, assuming the overall yield is 80%.

               Anggarkan nilai semua cip IC, andaikan hasil keseluruhan ialah 80%.

(5 marks/*markah*)

2.   (a)   (i)   Explain the fabrication processes of an accelerometer based on Figure 2.

               Terangkan proses-proses fabrikasi satu meter-pecutan berdasarkan Rajah 2.
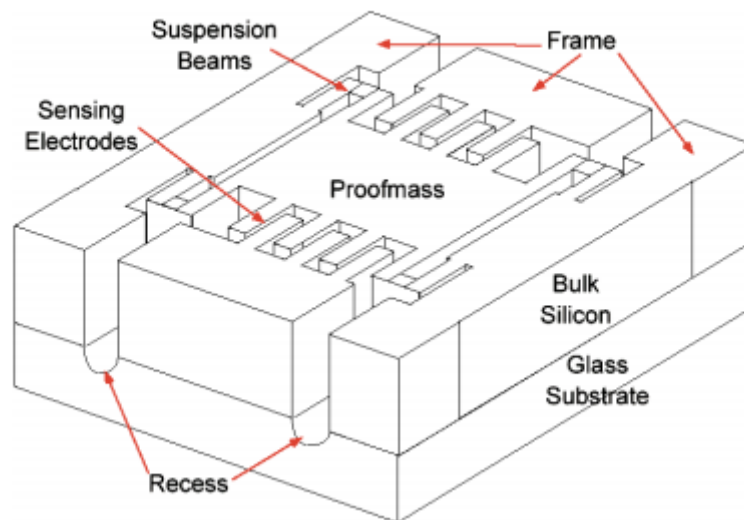
(25 marks/*markah*)

Figure 2

Rajah 2

(ii)   Calculate the value of capacitance at the sensing electrode for Figure 3 when the acceleration is zero. Use the following data.

Kira nilai kapasitan pada elektrod pengesan bagi Rajah 3 apabila pecutan ialah kosong. Guna data berikut.

Given: h_{comb}=10 μm, g_f=3 μm, L_f =80 μm.
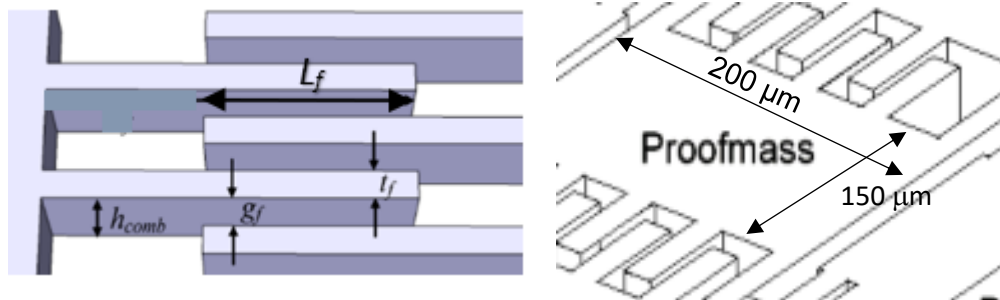
The dimensions are given in Figure 3.

Figure 3

Rajah 3

(5 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 ditingkatkan 2 kali ganda (b) Pengurangan nilai g_f sebanyak 50%.

(10 marks/*markah*)

(iv)   Estimate the capacitance value when g=10 and the spring constant k=50N/m.

Anggarkan nilai kapasitan apabila g=10 dan pemalar pegas k=50N/m.

(10 marks/*markah*)

(b)   Explain the differences of forming a polysilicon layer using negative resist and positive resist. Your explanation should be based on Figure 4. Draw the pattern of the mask to help your explanation.

Terangkan perbezaan bagi pembentukan lapisan polisilikon menggunakan rintang negatif dan rintang positif. Penerangan anda mestilah berdasarkan Rajah 4. Lukis corak topeng bagi membantu penerangan anda.
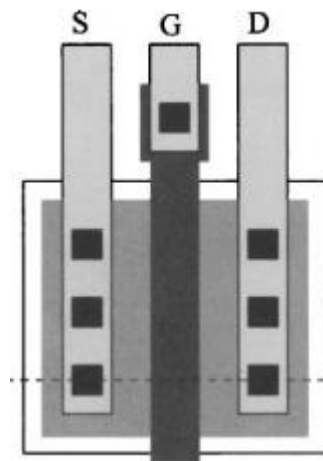
Figure 4

Rajah 4

(20 marks/*markah*)

(c)   Prototype of a tube with a square cross section is to be fabricated using Stereolithography. Calculate the time required to complete the prototype. Given, 10 seconds 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 dimension =100 mm

Inside dimension = 90 mm

Height = 80 mm

Prototaip bagi sebuah tiub yang mempunyai keratan rentas segiempat sama akan dibina menggunakan Stereolithografi. Kirakan masa untuk menyiapkan prototaip tersebut. 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:

Dimensi luar   =100 mm

Dimensi dalam   = 90 mm

Tinggi   = 80 mm

...7/-

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

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

(5 marks/*markah*)

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

Kira masa yang diperlukan untuk membina prototaip tersebut.

(10 marks/*markah*)

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

Terangkan perbezaan antara Stereolithografi dan Pembuatan Lakuran Mendapan dalam Prototaip Pantas.

(15 marks/*markah*)

3. (a) Define the term Manufacturing System.

Takrifkan Sistem Pembuatan.

(10 marks/*markah*)

(b) Determine **FIVE** common anatomies of commercial industrial robots with illustration of positioning and orientation.

*Tentukan **LIMA** anatomi yang biasa digunakan robot perindustrian komersil dengan ilustrasi kedudukan dan orientasi.*

(30 marks/*markah*)

(c) What is the difference between fixed automation, programmable automation and flexible automation? Illustrate of each of these automations into product in the production line.

Apakah perbezaan antara automasi tetap, automasi boleh atur dan automasi yang fleksibel? Ilustrasikan setiap automasi ini ke dalam barisan pengeluaran.

(60 marks/*markah*)

...8/-

4.   (a)   What are the advantages of a mixed model line over a batch model line for producing different product styles?

Apakah kelebihan garis model bercampur berbanding garis model kelompok untuk menghasilkan gaya produk yang berbeza?

(30 marks/*markah*)

(b)   Identify some of the details and decisions that are included within the scope of process planning.

Kenal pasti beberapa butiran dan keputusan yang termasuk dalam skop perancangan proses.

(30 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 (i) economic order quantity and (ii) total inventory costs for this situation.

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) ekonomi pesanan kuantiti dan (ii) jumlah kos inventori bagi keadaan ini.

(40 marks/*markah*)

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APPENDIX

LAMPIRAN

$$n_c = 0.34 \left(\frac{D_w}{L_c}\right)^{2.25}$$

Where n_c = the estimated number of chips on the wafer, D_w
=diameter of the processable area of the wafer (in mm),
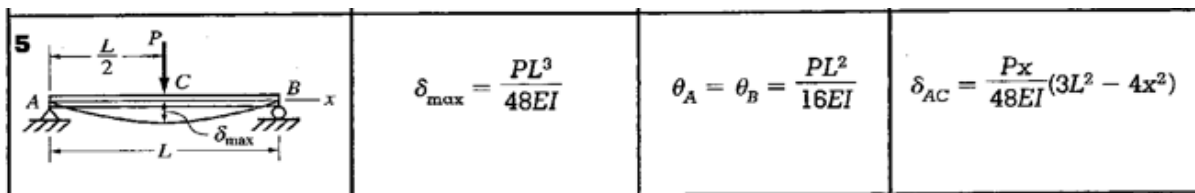and L_c=side dimension of the chip, mm

The volume of a cone = $\pi r^2 \frac{h}{3}$

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

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

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

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

5	$\delta_{max} = \dfrac{PL^3}{48EI}$	$\theta_A = \theta_B = \dfrac{PL^2}{16EI}$	$\delta_{AC} = \dfrac{Px}{48EI}(3L^2 - 4x^2)$

$E_{silicon}$ = 130 GPa

Density of silicon =2.32 $^g/_{cm^3}$