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UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
2009/2010 Academic Session

April/May 2010

**MSG 262 – Quality Control**  
***[Kawalan Mutu]***

Duration : 3 hours  
*[Masa : 3 jam]*

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Please check that this examination paper consists of NINE pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEMBILAN muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

**Instructions:** Answer **all four** [4] questions.

**Arahan:** Jawab **semua 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 diguna pakai].*

1. (a) Write short notes on the topics below:
- (i) Dimensions of quality
  - (ii) Bottlenecks
  - (iii) Firefighting
  - (iv) Internal and External customers
  - (v) Lean six sigma

[100 marks]

2. (a) What is Process Flow Analysis? Give an example to illustrate a process flow. Then identify possible bottlenecks in the process.

[30 marks]

- (b) List the tools you can use for quality control. Describe one SPC tool. Then show how it can be used for problem solving.

[30 marks]

- (c) In the manufacture of printed circuit boards (PCBs), finished boards are subjected to a final inspection before they are shipped to customers. During this inspection, defective boards are found and the types of defects are recorded. For a particular month, Table 2c shows the number of boards rejected at final inspection by a circuit board company's inspection department.

**Table 2c.** Rejected PCBs Classified by Type of Defect.

Type of Defect	No. of Rejected Boards
Poor electroless coverage	35
Lamination problems	10
Low copper plating	112
Plating separation	8
Etching problems	5
Miscellaneous	12

How shall the process improvement team in this PCB company analyze the data in Table 2c? Describe the analytical tool used. What are their findings? How should they carry out their corrective action?

[40 marks]

1. (a) *Tuliskan nota pendek tentang tajuk-tajuk di bawah:*
- (i) *Dimensi kualiti*
  - (ii) *'Bottlenecks'*
  - (iii) *'Firefighting'*
  - (iv) *Pelanggan dalam dan luar*
  - (v) *'Lean six sigma'*

[100 markah]

2. (a) *Apakah Analisis Aliran Proses? Beri satu contoh untuk mengilustrasikan aliran proses. Kemudian kenalpastikan 'bottleneck' yang mungkin di dalam proses.*

[30 markah]

- (b) *Senaraikan alat-alat yang anda dapat gunakan bagi kawalan mutu. Huraikan satu alat SPC. Kemudian tunjukkan bagaimana alat itu dapat digunakan untuk penyelesaian masalah.*

[30 markah]

- (c) *Dalam pengeluaran 'printed circuit board' (PCB), papan akhir diperiksa terakhir sekali sebelum dihantar kepada pelanggan. Semasa pemeriksaan ini, papan cacat dikesan dan jenis kecacatan dicatat. Bagi suatu bulan yang tertentu, Jadual 2c menunjukkan bilangan papan ditolak pada pemeriksaan akhir oleh jabatan pemeriksaan syarikat PCB.*

**Jadual 2c.** *Bilangan PCB ditolak mengikut jenis kecacatan.*

<b>Jenis Kecacatan</b>	<b>Bilangan PCB</b>
<i>Poor electroless coverage</i>	35
<i>Lamination problems</i>	10
<i>Low copper plating</i>	112
<i>Plating separation</i>	8
<i>Etching problems</i>	5
<i>Miscellaneous</i>	12

*Bagaimanakah pasukan pembaikan proses di syarikat PCB harus menganalisa data di dalam Jadual 2c? Huraikan alat analisis yang digunakan. Apakah keputusan mereka? Bagaimanakah mereka akan melaksanakan tindakan pembetulan?*

[40 markah]

3. (a) Why is stratification necessary in problem solving? Give an example to illustrate stratification in SPC. [20 marks]
- (b) Why are histograms listed as one of the Magnificent Seven? Sketch and comment on how histograms picture the stability of a process. [20 marks]
- (c) One measure of software quality is the error rate per 1,000 lines of code (Dunn, 1988). With the abbreviation 'K' for the word 'thousand', a block of 1,000 lines of computer code is often abbreviated as KLOC (K lines of code). The data in Table 3(c) show the defects per KLOC obtained from the daily test logs in a software company.

**Table 3(c).** Number of Errors per 1,000 Lines of Code (KLOC).

Day	# of Errors per KLOC	Day	# of Errors per KLOC
1	6	16	3
2	7	17	2
3	7	18	0
4	6	19	0
5	8	20	1
6	6	21	2
7	5	22	5
8	8	23	1
9	1	24	7
10	6	25	7
11	2	26	1
12	5	27	5
13	5	28	5
14	4	29	8
15	3	30	8

- (i) Construct an appropriate control chart for the data in Table 3(c).
- (ii) From the chart, obtain the average number of errors per KLOC, the upper and the lower control limits.
- (iii) Interpret the points on the control chart. What can you conclude?

[60 marks]

3. (a) *Mengapakah perlu penstratuman dalam penyelesaian masalah? Berikan satu contoh untuk menunjukkan penstratuman dalam SPC.*

[20 markah]

- (b) *Mengapakah histogram disenaraikan sebagai salah satu 'Magnificent Seven'? Lakar dan komen tentang bagaimana histogram menggambarkan kestabilan bagi suatu proses.*

[20 markah]

- (c) *Satu sukatan bagi kualiti perisian ialah kadar kesilapan setiap 1,000 kod talian (Dunn, 1988). Dengan bentuk pendek 'K' untuk perkataan 'ribuan', satu blok 1,000 talian kod computer sering dipendekkan sebagai KLOC (K kod talian). Data dalam Jadual 3(c) menunjukkan kecacatan setiap KLOC yang diperolehi dari catatan ujian harian dalam satu syarikat perisian.*

**Jadual 3(c).** *Bilangan Kesilapan setiap 1,000 Kod Talian (KLOC).*

<i>Hari</i>	<i>Bil. Kesilapan setiap KLOC</i>	<i>Hari</i>	<i>Bil. Kesilapan setiap KLOC</i>
1	6	16	3
2	7	17	2
3	7	18	0
4	6	19	0
5	8	20	1
6	6	21	2
7	5	22	5
8	8	23	1
9	1	24	7
10	6	25	7
11	2	26	1
12	5	27	5
13	5	28	5
14	4	29	8
15	3	30	8

- (i) *Bina satu carta kawalan yang sesuai untuk data dalam Jadual 3(c).*  
 (ii) *Dari carta, dapatkan purata bilangan kesilapan setiap KLOC, had-had kawalan atas dan bawah.*  
 (iii) *Tafsirkan titik-titik di atas carta kawalan. Apakah kesimpulan anda?*

[60 markah]

4. (a) Certain manufactured parts are required to have a length of 0.254 in. Twenty subgroups of three parts each were used to form X-bar and R charts for the part lengths. To simplify the data-gathering process, the measurements were reported as deviations from the nominal length in units of 0.0001 (e.g., a recorded value of -3 refers to a measured length of 0.251). In this format, the data on the 20 subgroups are given in Table 4(a).

**Table 4(a).** Measured Length of Three Parts.

Subgroup No.	P1	P2	P3
1	4	0	-2
2	-1	-3	-1
3	-2	4	2
4	-2	-2	1
5	0	-2	2
6	-1	0	2
7	-3	3	3
8	-2	-3	1
9	-3	1	3
10	3	1	1
11	-1	3	0
12	-2	-1	4
13	4	-1	3
14	-3	3	2
15	2	0	3
16	-3	1	-1
17	-2	2	1
18	-3	2	-1
19	-1	-2	0
20	1	-2	-1

- (i) Construct X-bar and R charts for the data in Table 4(a). Are there any indications that this process is not in control?
- (ii) Construct a CUSUM chart for the data in Table 4(a). Use  $h = 5\hat{\sigma}$ ,  $k = 0.5\hat{\sigma}$ , and  $w = 2\hat{\sigma}$  (estimate  $\sigma$  from the R chart). Interpret the resulting chart and compare these results to those in (i).
- (iii) Construct an EWMA chart for the data in Table 4(a). Use a parameter of  $\lambda = 0.30$ . Compare the resulting chart to those in (i) and (ii).

[60 marks]

4. (a) Bahagian tertentu yang dihasilkan perlu mempunyai panjang 0.254 in. Duapuluh subkumpulan setiap satu dengan tiga bahagian digunakan untuk membentuk carta X-bar dan carta R bagi panjang bahagian. Untuk memudahkan proses pengumpulan data, ukuran dicatatkan sebagai sisihan dari panjang nominal dalam unit 0.0001 (misalnya, nilai yang dicatat -3 bermaksud panjang 0.251). Dalam format ini, data bagi 20 subkumpulan diberi dalam Jadual 4(a).

**Jadual 4(a).** Ukuran Panjang bagi Tiga Bahagian.

<b>Nombor Subkumpulan</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>
1	4	0	-2
2	-1	-3	-1
3	-2	4	2
4	-2	-2	1
5	0	-2	2
6	-1	0	2
7	-3	3	3
8	-2	-3	1
9	-3	1	3
10	3	1	1
11	-1	3	0
12	-2	-1	4
13	4	-1	3
14	-3	3	2
15	2	0	3
16	-3	1	-1
17	-2	2	1
18	-3	2	-1
19	-1	-2	0
20	1	-2	-1

- (i) Bina carta X-bar dan carta R untuk data dalam Jadual 4(a). Adakah terdapat tanda-tanda bahawa proses inibukan dalam kawalan?
- (ii) Bina carta CUSUM untuk data dalam Jadual 4(a). Gunakan  $h = 5\text{sigmahat}$ ,  $k = 0.5\text{sigmahat}$ , and  $w = 2\text{sigmahat}$  (anggar sigma dari carta R). Tafsirkan carta yang diperoleh dan bandingkan keputusannya dengan keputusan dalam bahagian (i).
- (iii) Bina carta EWMA untuk data dalam Jadual 4(a). Gunakan parameter  $\lambda = 0.30$ . Bandingkan carta yang diperoleh dengan carta dalam (i) and (ii).

[60 markah]

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- (b) Why must a process be in statistical control before its capability is measured?

[5 marks]

- (c) Define process capability indices and describe how they may be used to monitor the capability of a process, its actual performance and its performance as perceived by a customer.

[20 marks]

- (d) Calculate the process capability indices for the data in Table 4(a). What is your conclusion?

[15 marks]



- (b) *Mengapakah proses harus dalam kawalan statistik sebelum keupayaannya diukur?*

*[5 markah]*

- (c) *Takrifkan indeks keupayaan proses dan huraikan bagaimana ia dapat digunakan untuk memantau keupayaan proses, prestasi sebenarnya, dan prestasinya dari persepsi pelanggan.*

*[20 markah]*

- (d) *Kirakan indeks keupayaan proses untuk data dalam Jadual 4(a). Apakah kesimpulan anda?*

*[15 markah]*