UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	QUALITY CONTROL
COURSE CODE	:	BPB 24303
PROGRAMME	:	2 BPB
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTIONS	:	A) ANSWER **ALL** QUESTIONS B) ATTACH APPENDIX 1 WITH YOUR ANSWER BOOKLET

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

Q1 (a) The production management of TEC refrigerator is interested in studying the types of defects that frequently detected at quality assurance (QA) section. Defect data for four months are given in **Table Q1(a)**. Indicator for " / " equal to 1 defect case.

Prepare a chart that most suitable for the above case.

(5 marks)

Table Q1(a)

Defect	**Frequency**
Refrigerator door	///// ///// ///// ///
Thermostat	////
Top cooling coil	///// ///// ///// ///// ///// ///// ///
Bottom cooling coil	///// ///// ///// //// //
Cooling control	///// ///// /
Swivel tray	///
Others	/////
Cooling regulators	///// ///// ///// ///// /

(b) The result of bonding strength of 40 tin soldering ponts are given in **Table Q1(b)**.

Table Q1(b)

22	22	22	22	22	22	22	22
23	23	23	23	23	20	20	20
25	25	25	25	25	25	25	25
46	46	46	46	46	46	20	20
52	52	52	52	52	52	52	52

(i) List the figures in **Table Q1(b)** in a frequency distribution.

(3 marks)

(ii) Calculate the cell interval range.

(3 marks)

(iii) Determine the cell boundaries.

(6 marks)

(iv) Scatch a histogram.

(3 marks)

Q2 (a) InnoValue is a metal stamping factory which always monitors its noise level in production floor. Records of noise measurements at prescribed locations through this large stamping facility are given in **Table Q2(a)**. Noise was measured in decibels (dB).

Table Q2(a)

Central Location (dB)	Frequency
147	3
138	4
129	9
120	12
111	28
102	36
95	44
84	34
75	21
66	13
57	7
48	5
39	3

(i) Calculate the average.

(2 marks)

(ii) Calculate the standard deviation.

(3 marks)

(b) Given the upper control limit (UCL) and lower control limit (LCL) were 7.50 and 7.10 respectively. The capability index before ($\sigma_0 = 0.015$) and after ($\sigma_0 = 0.012$) improvement and the average is 7.30.

(i) Calculate the C_p.

(2 marks)

(ii) Calculate the C_{pk}.

(4 marks)

(c) **Table Q2(c)** shows the average and range in tonne-forces for hardness tests on enhanced concrete super-slabs, before breaking points. The subgroup size is 4. By referring Table B in Appendix II:

Table Q2(c)

Subgroup Number	$\overline{X}$	R
1	475	33
2	465	25
3	483	33
4	465	27
5	469	25
6	493	25
7	485	29
8	495	24
9	489	25
10	481	25
11	497	26
12	463	25
13	483	25
14	481	23
15	505	24
16	497	24
17	477	26
18	483	25
19	505	24
20	475	26
21	484	30
22	489	26
23	462	23
24	470	28
25	473	23

(i) Calculate the trial central line and control limits without plotting the control chart.

(6 marks)

(ii) Calculate new central line, if any points are out of control.

(3 marks)

Q3 (a) Control charts for $\overline{X}$ and S are to be established on the Rockwell hardness of hardened tool steel in kilograms per square milimeter. Data for subgroup sizes of 8 are shown in **Table Q3.** By referring Table B in Appendix II:

Table Q3

Subgroup Number	$\overline{X}$	Std Deviation	Comment
1	538	28	
2	532	25	
3	543	26	
4	559	29	
5	574	27	
6	521	48	
7	569	31	
8	545	31	
9	582	25	New jig
10	550	26	
11	539	30	
12	543	27	
13	544	24	
14	549	26	
15	520	27	
16	577	28	
17	551	30	
18	506	25	Bad part
19	567	24	
20	572	30	
21	561	35	
22	563	25	
23	546	27	
24	554	29	
25	551	25	

(i) Calculate the central line.

(4 marks)

(ii) Calculate the control limits for $\overline{X}$.

(4 marks)

(iii) Calculate the control limit for S chart.

(4 marks)

(iv) Calculate new central line and control limits.

(8 marks)

Q4 (a) Toyogo Components Sdn. Bhd. has been manufacturing the DVD player plastic panels for a number of years. They use *p*-charts to keep track of the number of nonconforming panels that are created each time a batch. Use the data in **Table Q4** to create a fraction non-conforming *p*-chart. By referring Appendix I and Table B in Appendix II:

Table Q4

Subgroup Number	Number Inspected (n)	Number Nonconforming (np)
1	500	21
2	500	22
3	500	20
4	500	16
5	500	19
6	500	21
7	500	20
8	500	29
9	500	18
10	500	21
11	500	20
12	500	19
13	500	11
14	500	12
15	500	11
16	500	10
17	500	11
18	500	12
19	500	10
20	500	9
TOTAL	10000	332

(i) Calculate *p,* the fraction nonconforming.

(10 marks)

(ii) Calculate the central line and control limits.

(5 marks)

(iii) Plot on the graph paper the fraction nonconforming panels based on **Q4**(ii).

(5 marks)

Q5 (a) Describe **THREE (3)** phases of Failure Rate Curve (FRC).

(6 marks)

(b) Assume four of the lamps failed after 6, 8, 10 and 14 hours. Five lamps were still operating at the end of 22 hours.

Compute the failure rate for an item that the test of 9 lamps terminated at the end of 22 hours.

(2 marks)

(c) Compute the reliability at 30 hours and 40 hours where the mean life for a constant failure rate was at 55 hours.

(4 marks)

(d) The failure pattern of a new type of battery fits the Weibull distribution with slope 5.3 and mean life 115 hours.

Compute the reliability at 140 hours.

(2 marks)

(e) The method of arranging the components affects the reliability of the entire system. Components can be arranged in series, parallel or combination.

(i) A system has 6 components, i, ii, iii, iv, v and vi with reliability values of 0.977, 0.998, 0.899, 0.951, 0.975 and 0.913.

Compute the system reliability if the components are in series.

(2 marks)

(ii) The reliability of the components (i, ii, iii, iv, v and vi) in **Figure Q5** are 0.600, 0.623, 0.611, 0.682, 0.622 and 0.653.

Compute the reliability of the circuit.

(4 marks)

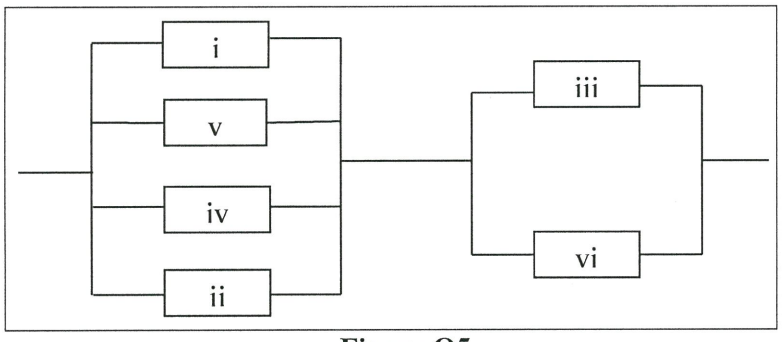

Figure Q5

-END OF QUESTION-

Appendix I

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Subgroup Number	Number Inspected (n)	Number Nonconforming (np)	Proportion (p)
1	500	21	
2	500	22	
3	500	20	
4	500	16	
5	500	19	
6	500	21	
7	500	20	
8	500	29	
9	500	18	
10	500	21	
11	500	20	
12	500	19	
13	500	11	
14	500	12	
15	500	11	
16	500	10	
17	500	11	
18	500	12	
19	500	10	
20	500	9	
TOTAL	10000	332	

Appendix II

FINAL EXAMINATION

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TABLE B Factors for Computing Central Lines and 3σ Control Limits for $\bar{X}$, s, and R Charts

OBSERVATIONS IN SAMPLE, n	CHART FOR AVERAGES: FACTORS FOR CONTROL LIMITS A	A_2	A_3	CHART FOR STANDARD DEVIATIONS: FACTOR FOR CENTRAL LINE c_4	FACTORS FOR CONTROL LIMITS B_3	B_4	B_5	B_6	CHART FOR RANGES: FACTOR FOR CENTRAL LINE d_2	FACTORS FOR CONTROL LIMITS d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	0	3.267	0	2.606	1.128	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	0	2.568	0	2.276	1.693	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	0	2.266	0	2.088	2.059	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	0	2.089	0	1.964	2.326	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	0.030	1.970	0.029	1.874	2.534	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	0.118	1.882	0.113	1.806	2.704	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	0.185	1.815	0.179	1.751	2.847	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	0.239	1.761	0.232	1.707	2.970	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	0.284	1.716	0.276	1.669	3.078	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	0.321	1.679	0.313	1.637	3.173	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	0.354	1.646	0.346	1.610	3.258	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	0.382	1.618	0.374	1.585	3.336	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	0.406	1.594	0.399	1.563	3.407	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	0.428	1.572	0.421	1.544	3.472	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	0.448	1.552	0.440	1.526	3.532	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	0.466	1.534	0.458	1.511	3.588	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	0.482	1.518	0.475	1.496	3.640	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	0.497	1.503	0.490	1.483	3.689	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	0.510	1.490	0.504	1.470	3.735	0.729	1.549	5.921	0.415	1.585

Appendix III

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$$C_p = \frac{USL - LSL}{6\sigma_0}$$

$$C_{pk} = \frac{Min\{(USL - \overline{X}) \text{ or } (\overline{X} - LSL)}{3\sigma}$$

$$\overline{\overline{X}} = \frac{\sum_{i=1}^{g} \overline{X_i}}{g} \quad and \quad \overline{R} = \frac{\sum_{i=1}^{g} R_i}{g}$$

$$UCL_{\overline{X}} = \overline{\overline{X}} + A_2\overline{R} \qquad UCL_R = D_4\overline{R}$$
$$LCL_{\overline{X}} = \overline{\overline{X}} - A_2\overline{R} \qquad LCL_R = D_3\overline{R}$$

$$\overline{\overline{X}}_{new} = \frac{\sum \overline{X} - \overline{X_d}}{g - g_d} \quad and \quad \overline{R}_{new} = \frac{\sum R - R_d}{g - g_d}$$

$$\overline{p} = \frac{\sum np}{\sum n}$$
$$UCL = \overline{p} + 3\sqrt{\frac{\overline{p}(1-\overline{p})}{n}}$$
$$LCL = \overline{p} - 3\sqrt{\frac{\overline{p}(1-\overline{p})}{n}}$$

Appendix IV

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$$\overline{p_{new}} = p_0 = \frac{\sum np - np_d}{\sum n - n_d}$$

$$UCL = p_0 + 3\sqrt{\frac{p_0(1-p_0}{n}}$$

$$LCL = p_0 - 3\sqrt{\frac{p_0(1-p_0)}{n}}$$

$$\bar{s} = \frac{\sum_{i=1}^{g} \bar{s}_i}{g} \qquad \bar{\bar{X}} = \frac{\sum_{i=1}^{g} \bar{X}_i}{g}$$

$$UCL_{\bar{X}} = \bar{\bar{X}} + A_3\bar{s} \qquad UCL_s = B_4\bar{s}$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - A_3\bar{s} \qquad LCL_s = B_3\bar{s}$$

$$\bar{X}_0 = \bar{\bar{X}}_{new} = \frac{\sum \bar{X} - \bar{X}_d}{g - g_d}$$

$$s_0 = \overline{s_{new}} = \frac{\sum s - s_d}{g - g_d} \qquad \sigma_0 = \frac{s_0}{c_4}$$

$$UCL_{\bar{X}} = \bar{X}_0 + A\sigma_0 \qquad UCL_s = B_6\sigma_0$$

$$LCL_{\bar{X}} = \bar{X}_0 - A\sigma_0 \qquad LCL_s = B_5\sigma_0$$

$$\lambda_{est} = \frac{r}{\sum t + (n-r)T}$$

$$R_t = e^{-t/\theta}$$

$$Rt = e^{-(t/\theta)\beta}$$