UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	QUALITY CONTROL
COURSE CODE	:	BPB 24303
PROGRAMME	:	2 BPB
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **ALL** QUESTIONS 2. ATTACH APPENDIX 1 WITH YOUR ANSWER BOOKLET

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

Q1 A structured problem solving process is introduced along with five of the seven quality improvement tools including pareto charts, cause and effect diagram, check sheets, histograms and control charts.

(a) The authority interested in identifying the types of defects that occured frequently. Six months data are given in **Table Q1(a).** Indicator for " / " equal to 10 parts. Construct a chart or diagram that most suitable for the above case.

(5 marks)

Table Q1(a): Check Sheet

Replacement Part	Frequency
Oven door	///// ///// ///// ////
Timer	/////
Front burners	///// ///// ///// ///// ///// ///// ////
Rear burners	///// ///// ///// //// ///
Burner control	///// ///// //
Drawer rollers	////
Other	///// /
Oven regulators	///// ///// ///// ///// //

(b) The result of relative strength of 50 silver solder welds are given in **Table Q1(b).**

Table Q1(b): Relative strength of 50 silver solder welds

2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	1.98
2.22	2.22	2.22	2.22	2.22	1.95	1.95	1.95	1.95	1.98
2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43	1.98
4.53	4.53	4.53	4.53	4.53	4.53	1.98	1.98	1.98	1.98
5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12

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

(2 marks)

(ii) Calculate the cell interval.

(2 marks)

(iii) Calculate number of classes.

(6 marks)

(iv) Determine the cell boundaries.

(2 marks)

(v) Illustrate a histogram.

(3 marks)

Q2 (a) Test of noise ratings at prescribed locations through a large stamping mill are given in **Table Q2(a)**. Noise was measured in decibels.

Table Q2(a): Frequency distribution

Cell Midpoint	Frequency
148	2
139	3
130	8
121	11
112	27
103	35
94	43
85	33
76	20
67	12
58	6
49	4
40	2

(i) Calculate the average. (2 marks)

(ii) Calculate the standard deviation. (3 marks)

(b) Given the upper specification limit (USL) and lower specification limit (LSL) were 7.40 and 7.20 respectively. The capability index before (σ_0= 0.015) and after (σ_0 = 0.012) improvement and the average is 7.25.

(i) Calculate the Cp. (2 marks)

(ii) Calculate the Cpk. (4 marks)

(c) Table Q2(c) shows the average and range in kilograms for tensile tests on an improved plastic cord. The subgroup size is 4. By referring Table B in Appendix II.

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

(6 marks)

(ii) If any points are out of control, calculate new central line.

(3 marks)

Table Q2(c): Average and range in kilograms for tensile tests

Subgroup Number	$\overline{X}$	R
1	476	32
2	466	24
3	484	32
4	466	26
5	470	24
6	494	24
7	486	28
8	496	23
9	488	24
10	482	26
11	498	25
12	464	24
13	484	24
14	482	22
15	506	23
16	496	23
17	478	25
18	484	24
19	506	23
20	476	25
21	485	29
22	490	25
23	463	22
24	469	27
25	474	22

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

(a) Calculate the central line.

(4 marks)

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

(4 marks)

(c) Calculate the control limit for S chart.

(4 marks)

(d) If any points are out of control, calculate new central line and control limits.

(8 marks)

Table Q3(a): Hardened tool steel in kilograms per square milimeter

Subgroup Number	$\overline{X}$	Std Deviation	Comment
1	540	26	
2	534	23	
3	545	24	
4	561	27	
5	576	25	
6	523	50	
7	571	29	
8	547	29	
9	584	23	New operator
10	552	24	
11	541	28	
12	545	25	
13	546	26	
14	551	24	
15	522	29	
16	579	26	
17	549	28	
18	508	23	Bad Material
19	569	22	
20	574	28	
21	563	33	
22	561	23	
23	548	25	
24	556	27	
25	553	23	

Q4 Star Plastic Sdn Bhd has been making the credits card for a number of years. They use *p*-charts to keep track of the number of nonconforming cards that are created each time a batch. Use the data in **Table Q4(a)** to create a fraction non-conforming *p*-chart. By referring Appendix I and **Table B** in Appendix II.

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

(10 marks)

(b) Calculate the central line and control limits.

(5 marks)

(c) Plot on the graph paper the fraction nonconforming cards based on Q4(a)(ii).

(5 marks)

Table Q4(a): Nonconforming cards

Subgroup Number	Number Inspected (n)	Number Nonconforming (np)
1	500	20
2	500	21
3	500	19
4	500	15
5	500	18
6	500	20
7	500	19
8	500	28
9	500	17
10	500	20
11	500	19
12	500	18
13	500	10
14	500	11
15	500	10
16	500	9
17	500	10
18	500	11
19	500	9
20	500	8
TOTAL	10000	312

Q5 (a) Explain three phases of Failure Rate Curve.

(6 marks)

(b) Assume four of the lamps failed after 5, 7, 9 and 15 hours. Five lamps were still operating at the end of 20 hours.
Calculate the failure rate for an item that the test of 9 lamps terminated at the end of 20 hours.

(2 marks)

(c) Calculate the reliability at t=20 hours and t=30 hours where the mean life for a constant failure rate was at 45 hours.

(4 marks)

(d) The failure pattern of a new type of battery fits the Weibull distribution with slope 5.2 and mean life 105 hours.
Calculate the reliability at 130 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 7 components, i, ii, iii, iv, v, vi and vii with reliability values of 0.877, 0.898, 0.799, 0.851, 0.875, 0.813 and 0.843.
Calculate the system reliability if the components are in series.

(2 marks)

(ii) The reliability of the components (i, ii, iii, iv, v, vi and vii) in Figure Q(e)(ii) are 0.500, 0.523, 0.511, 0.582, 0.522, 0.553 and 0.653.
Calculate the reliability of the circuit.

(4 marks)

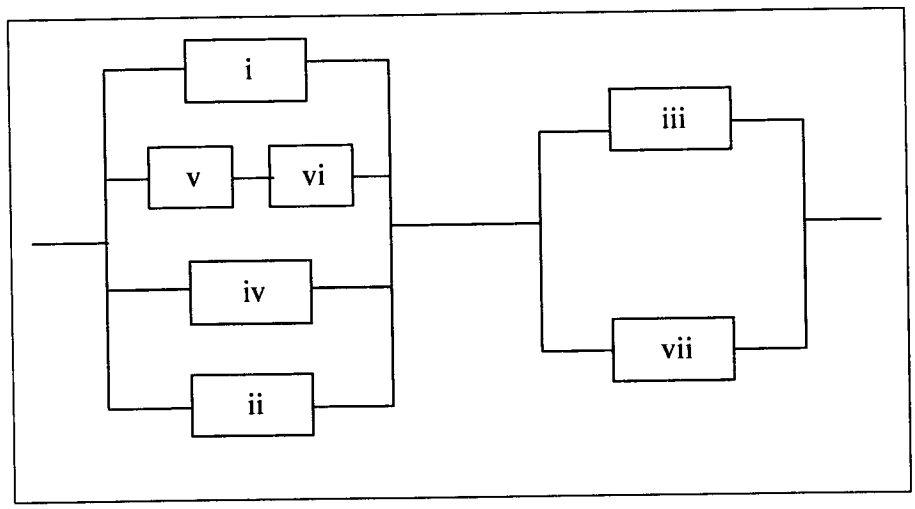

Figure Q (e) (ii): Reliability of a circuit.

END OF QUESTION PAPER

Appendix I

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2011/2012
COURSE : QUALITY CONTROL

PROGRAMME : 2 BPB
COURSE CODE : BPB 24303

Subgroup Number	Number Inspected (n)	Number Nonconforming (np)	Proportion (p)
1	500	20	
2	500	21	
3	500	19	
4	500	15	
5	500	18	
6	500	20	
7	500	19	
8	500	28	
9	500	17	
10	500	20	
11	500	19	
12	500	18	
13	500	10	
14	500	11	
15	500	10	
16	500	9	
17	500	10	
18	500	11	
19	500	9	
20	500	8	
TOTAL	10000	312	

Appendix II

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2011/2012
COURSE : QUALITY CONTROL

PROGRAMME : 2 BPB
COURSE CODE : BPB 24303

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

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2011/2012
COURSE : QUALITY CONTROL

PROGRAMME : 2 BPB
COURSE CODE : BPB 24303

Process Capability Cp Cpk

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

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

Trial Central Line and Control Limits

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

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

Revised Central Line and Control Limits

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

Trial Central Line and the Control Limits

$$\overline{p} = \frac{\sum np}{\sum n}$$

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

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

Appendix IV

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2011/2012
COURSE : QUALITY CONTROL

PROGRAMME : 2 BPB
COURSE CODE : BPB 24303

The Revised Central Line and Control Limits

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

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

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

Trial Central Line and The Control Limits

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

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

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

Revised Limits for s chart

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

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

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

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

Failure Rate Curve

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

Exponential Failure Analysis

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

Weibull Failure Analysis

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