UNIVERSITY OF JOHANNESBURG

PROGRAM : BEng Tech ENGINEERING: INDUSTRIAL

SUBJECT : **QUALITY ASSURANCE 2A**

CODE : **QUAMIA2**

DATE : WINTER XAMINATION
5 JUNE 2018

DURATION : (SESSION 1) 08:30 AM-11:30 AM

WEIGHT : 40 : 60

TOTAL MARKS : 100

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MODERATOR : MR GOODWEL MUYENGWA

NUMBER OF PAGES : 10 PAGES

INSTRUCTIONS :

- DRAWING INSTRUMENTS.
- A CALCULATOR OF ANY MAKE OR MODEL IS PERMITTED.

REQUIREMENTS:

- 2 SHEETS GRAPH PAPER.

QUESTION 1

1.1 Give a comprehensive clarification of the following tools:

1.1.1 QFD (3)

1.1.2 ISO 9000 (3)

1.1.3 Quality by Design (3)

1.1.4 Benchmarking (3)

[12]

QUESTION 2

2.1 Discuss the 5S in a good workplace organisation (10)

2.2 Give a detailed procedure for establishing control charts (6)

[16]

QUESTION 3

3. An air-conditioning repair department manager has compiled data on the primary reason for 42 service calls for the previous week as shown in Table Q1. Using the data:

3.1 make a check sheet for the problem types; (4)

3.2 construct a Pareto diagram for the problem types; (6)

3.3 construct the associated cumulative line; (4)

3.4 list problems that constitute approximately 71% of the problems. (2)

[16]

Table Q1

Job No.	Problem	Job No.	Problem	Job No.	Problem
301	F	315	F	329	O
302	O	316	O	330	N
303	N	317	W	331	D
304	D	318	N	332	W
305	W	319	O	333	O
306	N	320	F	334	O
307	F	321	D	335	N
308	N	322	O	336	W
309	W	323	F	337	D
310	N	324	N	338	N
311	N	325	F	339	F
312	F	326	O	340	N
313	N	327	W	341	O
314	W	328	O	342	D

Key- Problem type:
N = Noisy
F= Equipment failure
W = Runs warm
O = Odour
D = Door not closing

QUESTION 4

The following tables gives the average and range in kilograms for tensile tests on an improved plastic cord. The subgroup size is 4.

Subgroup number	X bar	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

Determine the trial and control limits. Assume that out-of-control points have assignable causes. Calculate the revised limits and central line and plot both graphs. (20)

[20]

QUESTION 5

A random sample of 4 bank accounts is selected from a lot of 12 that has 3 nonconforming units. Using the hypergeometric distribution determine the probability that the sample will contain exactly:

4.1 zero nonconforming units; (3)
4.2 one nonconforming unit; (3)
4.3 two nonconforming units; (3)
4.4 three nonconforming units; (3)
4.5 four nonconforming units. (4)

[16]

QUESTION 6

The following table shows the inspection results of components by suppliers:

Supplier	Number conforming	Number Nonconforming	Total
A	100	6	106
B	225	12	262
C	150	4	154
Total	500	22	522

If the 261 parts described in the table are contained in a box:

6.1 What is the probability that a randomly selected part from the box will be from supplier A or a nonconforming unit? (4)

6.2 What is the probability that a randomly selected part from the box will be from supplier A or supplier C? (4)

[8]

QUESTION 7

A manufacturer of light bulbs has decided what constitutes a defective bulb.

Subgroup Number	Number Inspected	Number Defective	Subgroup Number	Number Inspected	Number Defective
1	300	3	14	300	6
2	300	6	15	300	7
3	300	4	16	300	4
4	300	6	17	300	5
5	300	20	18	300	7
6	300	2	19	300	5
7	300	6	20	300	0
8	300	7	21	300	2
9	300	3	22	300	3
10	300	0	23	300	6
11	300	6	24	300	1
12	300	9	25	300	8
13	300	5			

7.1 Determine the trial central line and control limits using the following data, which are for bulb manufacturer. (6)

7.2 If there are any out of control points, assume assignable cause and determine the revised control line and control limits. (6)

[16]

TOTAL AVAILABLE=100 MARKS

ANNEXURE

FORMULA SHEET

1. Measures of Central Tendency

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}; \qquad \bar{X} = \frac{\sum_{i=1}^{n} f_i X_i}{n}; \qquad \bar{X}_w = \frac{\sum_{i=1} w_i \bar{X}_i}{\sum_{i=1}^{n} w_i}$$

$$Md = L_m + \left(\frac{\frac{n}{2} - cf_m}{f_m} \right) i;$$

2. Measures of Dispersion

$$R = X_h - X_l; \qquad s = \sqrt{\frac{\sum_{i=1}^{n}\left(X_i - \bar{X}\right)^2}{n-1}}; \qquad s = \sqrt{\frac{n\sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2}{n(n-1)}}$$

$$Z = \frac{X_i - \mu}{\sigma}$$

3. Scatter Diagram

$$m = \frac{\sum xy - [(\sum x)(\sum y)/n]}{\sum x^2 - [(\sum x)^2/n]}; \qquad a = \sum \frac{y}{n} - m\left(\sum \frac{x}{n}\right); \qquad y = a + mx;$$

$$r = \frac{\sum xy - [(\sum x)(\sum y)/n}{\left(\sum x^2 - [(\sum x)^2/n]\right)\left(\sum y^2 - [(\sum y)^2/n]\right)}.$$

4. Control Charts – variables

Trial Control Limits

$$\bar{\bar{X}} = \frac{\sum_{i=1}^{g} \bar{X}_i}{g}; \qquad \bar{R} = \frac{\sum_{i=1}^{g} R_i}{g};$$

$$UCL_{\bar{X}} = \bar{\bar{X}} + 3\sigma_{\bar{X}}; \qquad UCL_R = \bar{R} + 3\sigma_R;$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - 3\sigma_{\bar{X}}; \qquad UCL_R = \bar{R} - 3\sigma_R;$$

$$UCL_{\bar{X}} = \bar{\bar{X}} + A_2 R; \qquad UCL_R = D_4 \bar{R};$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \bar{R}; \qquad LCL_R = D_3 \bar{R}.$$

Revised Control Limits

$$\bar{\bar{X}}_{new} = \frac{\sum \bar{X} - \bar{X}_d}{g - g_d}; \qquad \bar{R}_{new} = \frac{\sum R - R_d}{g - g_d};$$

$$\bar{X}_0 = \bar{X}_{new}; \qquad R_0 = \bar{R}_{new}; \qquad \sigma_0 = \frac{R_0}{d_2}$$

$$LCL_{\bar{X}} = \bar{X}_0 + A\sigma_0; \qquad LCL_{\bar{X}} = \bar{X}_0 - A\sigma_0;$$

$$UCL_R = D_2\sigma_0; \qquad LCL_R = D_1\sigma_0$$

5. Sample Standard Deviation Control Chart

Trial Control Limits

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

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

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

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Revised Control Limits

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

$$s_0 = \bar{s}_{new} = \frac{\sum s - s_d}{g - g_d}; \qquad \sigma_0 = \frac{s_0}{c_4}$$

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

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

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6. Process Capability

$$\bar{R} = \frac{\sum R}{g}; \qquad \hat{\sigma} = \frac{\bar{R}}{c_4}; \qquad \hat{\sigma} = \frac{\bar{s}}{d_2}$$

$$\sigma_0 = \frac{\bar{R}}{d_2}; \qquad \bar{s} = \frac{\sum s}{g}; \qquad \sigma_0 = \frac{\bar{s}}{c_4};$$

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

$$C_{pk} = \frac{Min\{\left(USL - \bar{X}\right) or \left(\bar{X} - LSL\right)}{3\sigma}$$

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7. Discrete Probability Distributions

Hypergeometric Probability Distribution

$$P(d) = \frac{C_d^D C_{n-d}^{N-D}}{C_n^N}; \qquad \mu = \frac{nD}{N}; \qquad \sigma = \sqrt{\frac{\frac{nD}{N}\left(1-\frac{D}{N}\right)(N-n)}{N-1}}$$

Binomial Probability Distribution

$$(p+q)^2 = p^n + np^{n-1}q + \frac{n(n-1)}{2}p^{n-2}q^2 + \ldots\ldots + q^n$$

$$P(d) = \frac{n!}{d!(n-d)!}p_0^d q_0^{n-d}$$

$$\mu = np_0; \qquad \sigma = \sqrt{np_0(1-p_0)}$$

Poisson Probability Distribution

$$P(c) = \frac{(np_0)^c}{c!}e^{-np_0}; \qquad \mu = np_0; \qquad \sigma = \sqrt{np_0}$$

8. Control charts – Attributes

$$n = p(1-p)\left(\frac{\frac{Z_\alpha}{2}}{E}\right)^2$$

p – Chart : – Trial Control Limits

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

p – Chart :– Revised Control Limits

$$\bar{p}_{new} = \frac{\sum np - np_d}{\sum n - n_d}; \qquad p_0 = \bar{p}_{new}$$

$$UCL = p_0 + 3\sqrt{\frac{p_0(1-p_0)}{n}}; \qquad LCL = p_0 - 3\sqrt{\frac{p_0(1-p_0)}{n}}$$

c – chart : - Trial Control Limits

$$UCL = \bar{c} + 3\sqrt{\bar{c}}; \qquad LCL = \bar{c} - 3\sqrt{\bar{c}}; \qquad \bar{c} = \frac{\sum c}{g}$$

c- chart : - Revised Control Limits

$$\bar{c}_{new} = \frac{\sum c - c_d}{g - g_d}; \qquad UCL = c_0 + 3\sqrt{c_0}; \qquad LCL = c_0 - 3\sqrt{c_0}$$

u – chart

$$u = \frac{c}{n}; \qquad \bar{u} = \frac{\sum c}{\sum n}$$

$$UCL = \bar{u} + 3\sqrt{\frac{\bar{u}}{n}}; \qquad LCL = \bar{u} - 3\sqrt{\frac{\bar{u}}{n}}$$

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			CHART FOR STANDARD DEVIATIONS: FACTOR FOR CENTRAL LINE	CHART FOR STANDARD DEVIATIONS: FACTORS FOR CONTROL LIMITS				CHART FOR RANGES: FACTOR FOR CENTRAL LINE	CHART FOR RANGES: FACTORS FOR CONTROL LIMITS				
	A	A_2	A_3	c_4	B_3	B_4	B_5	B_6	d_2	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