UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA ENGINEERING : INDUSTRIAL
SUBJECT	:	**QUALITY ASSURANCE 2**
CODE	:	**BQA 2111**
DATE	:	WINTER EXAMINATION 9 JUNE 2014
DURATION	:	(SESSION 1) 08:30 - 11:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

ASSESSOR	:	MR F CHIROMO
MODERATOR	:	MR G MUYENGWA
NUMBER OF PAGES	:	4 PAGES + 2 ANNEXURES

REQUIREMENTS:

- 6 SHEETS GRAPH PAPER.

2/...

INSTRUCTIONS TO STUDENTS:

- ANSWER ALL QUESTIONS.
- A STUDENT IS EXPECTED TO MAKE REASONABLE ASSUMPTIONS FOR DATA NOT SUPPLIED.
- NUMBER YOUR QUESTIONS CLEARLY AND UNDERLINE THE FINAL ANSWER.
- ANSWERS WITHOUT UNITS WILL BE IGNORED.

QUESTION 1

1 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:

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

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

1.3 construct the associated cumulative line; (4)

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

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

[16]

QUESTION 2

Data on gas pressure (kg/cm^2) and its volume (litres) are as shown in Table Q2..

Table Q2

Gas Pressure (kg/cm^2)	Volume (litres)
0.5	1.62
1.5	0.75
2.0	0.62
3.0	0.46
2.5	0.52
1.0	1.00
0.8	1.35
1.2	0.89
2.8	0.48
3.2	0.43
1.8	0.71
0.3	1.80

2.1 Construct the relevant scatter diagram. (8)
2.2 Determine the:
2.2.1 coefficient of correlation; (4)
2.2.2 equation of the line; (4)
[16]

QUESTION 3

Processing new accounts at a bank is intended to average 10 minutes each. Five samples of four observations each have been taken. Detail of the samples are given in Table Q3.

Table Q3

Observation	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
1	10.2	10.3	9.7	9.9	9.8
2	9.9	9.8	9.9	10.3	10.2
3	9.8	9.9	9.9	10.1	10.3
4	10.1	10.4	10.1	10.5	9.7

3.1 Use the data to construct the mean and range charts. (16)
3.2 Discuss what the results suggest. (4)
[20]

QUESTION 4

A random sample of 4 insurance claims 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 5

A manufacturer of light bulbs has decided what constitutes a defective bulb. Samples of 200 bulbs have been inspected on each of the last 20 days. The numbers of defectives found are given below.

Table Q5

Day	Number Defective	Day	Number Defective
1	4	11	6
2	1	12	12
3	6	13	7
4	3	14	9
5	8	15	9
6	10	16	6
7	7	17	2
8	3	18	4
9	2	19	5
10	2	20	1

5.1 Construct a 'p' chart for the data (12)
5.2 Explain what should be done next. (4)
[16]

QUESTION 6

A real estate firm evaluates incoming selling agreement forms using the single sampling plan; N = 5 000, n =80 and c = 2.
Construct the operating characteristics curve using 8 points (16)
[16]

TOTAL = 100

ANNEXURE A

FORMULA SHEET

1. Measures of Central Tendency

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

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

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

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

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

4. Control Charts – variables

Trial Control Limits

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

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

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

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

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

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

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

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

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

Revised Control Limits

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

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

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

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

6. Process Capability

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

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

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

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

7. Discrete Probability Distributions

Hypergeometric Probability Distribution

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

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

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

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

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

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

ANNEXURE B

Observations in Sample, n	CHART FOR AVERAGES			CHART FOR STANDARD DEVIATIONS					CHART FOR RANGES						
	Factors for Control Limits			Factor for Central Line	Factors for Control Limits				Factor for Central Line		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	