UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA ENGINEERING : INDUSTRIAL
SUBJECT	:	**QUALITY ASSURANCE 2**
CODE	:	**BQA 2111**
DATE	:	WINTER EXAMINATION 01 JUNE 2019
DURATION	:	(SESSION 1) 08:30 - 11:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

ASSESSOR	:	Ms R. MOUCHOU	
MODERATOR	:	Dr. G. MUYENGWA	2187
NUMBER OF PAGES	:	4 PAGES + 1 ANNEXTURE	

INSTRUCTIONS :

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

REQUIREMENTS:

- 2 SHEETS GRAPH PAPER.

QUESTION 4

Question 1

1. What is Lean enterprise? (4)
2. Describe and discuss 2 types of quality improvement tools (8)
3. Describe and discuss 3 types of the lean fundamentals (15)

[27]

Question 2

If there are 11 parts in a product and they are each at 6 sigma with a 1.5 shift when process is off center, determine the number of parts per million (PPm) for the products

[6]

Question 3

Pty Construction Company needs a Pareto diagram for the analysis of the following design department cost of poor quality

Element	Rand (in Thousands)
Progress review	24
Qualification tests	48
Support review	27
Corrective action	33
All other	24
Rework	10
Inspection cost	22
Scrap	41
Expense	53

3.1. Using data above and construct a histogram (included a prepare table showing tally sheet and all others keys points for histogram diagram) **[15]**

QUESTION 4

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; (5)
1.2 construct a Pareto diagram for the problem types; (7)
1.3 construct the associated cumulative line; (5)
1.4 list problems that constitute approximately 71% of the problems. (3)

[20]

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 5

1) An existing process is not meeting the rock specifications. Data are 7, 5, 5, 3, 2, 4, 5, 9, 4, 5, 4, 7, 5, 7, 3, 4, 4, 5, 6, 4, 7, 7, 5, 5, and 7.

1.1. Determine the process capability based on the range value for 25 subgroups of size 4 (4)

1.2. Calculate the estimate of the population standard deviation (3)

2) Assume that the specifications are 6.50 and 6.30 in the depth of keyway problem.

2.1. Determine the capability index before (sigma=0.038) and after (sigma=0.030) improvement. (4)

[11]

Question 6

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; (4)
4.2 one nonconforming unit; (4)
4.3 two nonconforming units; (4)
4.4 three nonconforming units; (4)
4.5 four nonconforming units. (5)

[21]

ANNEXURE A

FORMULA SHEET

1. Measures of Central Tendency

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

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

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

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

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

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

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

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

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

.

Revised Control Limits

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

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

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

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

.

6. Process Capability

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

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

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

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

7. Discrete Probability Distributions
Hypergeometric Probability Distribution

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

.

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

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

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

.

ANNEXURE B

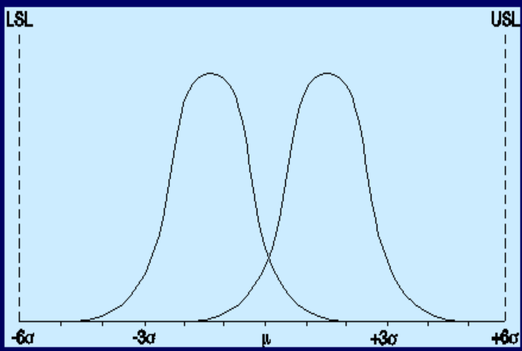

Figure 3-2 Non-conformance rate when process is off center ±1.5σ

SPECIFICATION LIMIT	PERCENT CONFORMANCE	NONCONFORMANCE RATE (PPM)	PROCESS CAPABILITY (C_{PK})
$\pm 1\sigma$	30.23	697,700	−0.167
$\pm 2\sigma$	69.13	308,700	0.167
$\pm 3\sigma$	93.32	66,810	0.500
$\pm 4\sigma$	99.3790	6,210	0.834
$\pm 5\sigma$	99.97670	2,330	1.167
$\pm 6\sigma$	99.9996600	3.4	1.500

Table 3-2 Non-conformance rate when process is off center ±1.5σ

Quality Improvement, 9e
Dale H. Besterfield

7