UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA ENGINEERING : INDUSTRIAL
SUBJECT	:	**QUALITY ASSURANCE 2**
CODE	:	**BQA 2111**
DATE	:	WINTER SSA EXAMINATION 19 JULY 2019
DURATION	:	(SESSION 1) 8:00 – 11:00
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

ASSESSOR	:	Ms. R MOUCHOU
MODERATOR	:	Dr. G MUYENGWA
NUMBER OF PAGES	:	4 PAGES + 2 ANNEXURES

REQUIREMENTS:

- 3 SHEETS GRAPH PAPER PER STUDENT

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

Under Total Quality Management what is the role of:

4.1 Leadership; (8)

4.2 Employees. **(8)**

[16]

Question 2

Under Six Sigma Describe DMAIC project methodology **[10]**

QUESTION 3

1.1 Prepare a scatter diagram for the data set given in Table Q1. (6)

1.2 Determine the:

1.2.1 coefficient of correlation; (4)

1.2.2 equation of the line; (4)

1.3 Express in words the apparent relationship between the two variables. (4)

Table Q1

Age	24	30	22	25	33	27	36	58	37	47	54	28	42	55
Absenteeism rate	6	5	7	6	4	5	4	1	3	2	2	5	3	1

[18]

Question 4

1. Below are the readings obtained in the production line by a motion and time study analyst who took 6 readings per cycle each day for 10 days.

a) Construct a tally sheet (2 marks)

b) Using the data below , construct a histogram (14 marks)

[16]

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

QUESTION 5

Random samples each with a sample size of six, are periodically taken from a production line that manufactures one-half-volt batteries. The sampled batteries are tested on a voltmeter. The production line has just been modified, and a new quality control plan must be designed. For that purpose, 10 random samples (of 6 each) have been taken over a suitable period of time. The test results are as follows:

Sample Number	Tested Voltages					
	V_1	V_2	V_3	V_4	V_5	V_6
1	0.498	0.492	0.510	0.505	0.504	0.487
2	0.482	0.491	0.502	0.481	0.496	0.492
3	0.501	0.512	0.503	0.499	0.498	0.511
4	0.498	0.486	0.502	0.503	0.510	0.501
5	0.500	0.507	0.509	0.498	0.512	0.518
6	0.476	0.492	0.496	0.521	0.505	0.490
7	0.511	0.522	0.513	0.518	0.520	0.516
8	0.488	0.512	0.501	0.498	0.492	0.498
9	0.482	0.490	0.510	0.500	0.495	0.482
10	0.505	0.496	0.498	0.490	0.485	0.499

3.1 Draw the mean and range charts for the data. (16)
3.2 Discuss what should be done next. (4)

[20]

QUESTION 6

A random sample of 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:

5.1 zero nonconforming units; (3)
5.2 one nonconforming unit; (3)
5.3 two nonconforming units; (3)
5.4 three nonconforming units; (3)

5.5 four nonconforming units. (3)

5.6 Draw the hypergeometric distribution based on the data given. (5)

[20]

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

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

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

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

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

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

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

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

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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

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

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

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

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

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6. Process Capability

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

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

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

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

7. Discrete Probability Distributions
Hypergeometric Probability Distribution

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

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Binomial Probability Distribution

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

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

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

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Poisson Probability Distribution

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

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8. Control charts – Attributes

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

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p – Chart : – Trial Control Limits

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

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p – Chart :– Revised Control Limits

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

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

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c – chart : - Trial Control Limits

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

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c- chart : - Revised Control Limits

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

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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