UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA ENGINEERING : INDUSTRIAL
SUBJECT	:	**QUALITY ASSURANCE 2**
CODE	:	**BQA 2111**
DATE	:	WINTER EXAMINATION 6 JUNE 2016
DURATION	:	(SESSION 2) 12:30 - 15:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

ASSESSOR	:	MR AMUKELANI BALOYI
MODERATOR	:	MR OMPHEMETSE SEPHOTI
NUMBER OF PAGES	:	10 PAGES

INSTRUCTIONS :

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

REQUIREMENTS:

- 3 SHEETS GRAPH PAPER.

QUESTION 1

1.1 Give a brief description of the following tools:

1.1.1 FMEA (5)

1.1.2 ISO14000 (4)

1.1.3 Quality by Design (3)

[12]

QUESTION 2

2.1 Discuss the seven categories of waste (14)

2.2 What does DMAIC stand for? (5)

[19]

QUESTION 3

Make a check sheet and then a Pareto diagram for the following car repair shop data:

Ticket No.	*Work*	*Ticket No.*	*Work*	*Ticket No.*	*Work*
1	*Tyres*	*11*	*Brakes*	*21*	*Lube & oil*
2	*Lube & oil*	*12*	*Lube & oil*	*22*	*Brakes*
3	*Tyres*	*13*	*Battery*	*23*	*Transmission*
4	*Battery*	*14*	*Lube & oil*	*24*	*Brakes*
5	*Lube& oil*	*15*	*Lube & oil*	*25*	*Lube & oil*
6	*Lube & oil*	*16*	*Tyres*	*26*	*Battery*
7	*Lube & oil*	*17*	*Lube & oil*	*27*	*Lube & oil*
8	*Brakes*	*18*	*Brakes*	*28*	*Battery*
9	*Lube & oil*	*19*	*Tyres*	*29*	*Brakes*
10	*Tyres*	*20*	*Brakes*	*30*	*Tyres*

[20]

QUESTION 4

4.1 Give a detail account of the three (3) categories of variation in piece part production. [6]

4.2 Control charts for X bar and *s* are to be established on the Brinell hardness of hardened tool steel in kilograms per square millimetre. Data for subgroup size of 8 are shown below.

Subgroup number	X bar	s
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
10	552	24
11	541	28
12	545	25
13	546	26
14	551	24
15	522	24
16	579	26
17	549	28
18	508	23
19	569	22
20	574	28
21	563	33
22	561	23
23	548	25
24	556	27
25	553	23

Determine the trial and control limits for the X bar and *s* charts. Assume that out-of-control points have assignable causes. Calculate the revised limits and central line. [15]

[21]

QUESTION 5

Determine the number of subgroup needed to establish the central lines and control limits for X bar and R chart with a subgroup size of 2 for an 8-spindle filling machine. How many times in succession can one of the spindle be plotted?

[4]

QUESTION 6

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

Supplier	*Number Acceptable*	*Number Defective*	*Total*
A	*80*	*4*	*84*
B	*140*	*8*	*148*
C	*88*	*3*	*91*
Total	*308*	*15*	*323*

If the 323 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 C, a defective from supplier A, or an acceptable from supplier B? (5)

6.2 What is the probability that a randomly selected part from the box will be from supplier A or a defective? *(5)*

[10]

QUESTION 7

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

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

Assuming uniform wear, determine:

7.1 Construct a 'p' chart for the data (12)

7.2 Explain what should be done next. (4)

[16]

AVAILABLE TOTAL=104 MARKS

ANNEXURE

FORMULA SHEET

1. Scatter Diagram

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

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

2. Control Charts – variables

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

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

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

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

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

3. Sample Standard Deviation Control Chart

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

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

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

4. Process Capability

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

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

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

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

5. Discrete Probability Distributions

Hypergeometric Probability Distribution

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

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Probability

P(A or B)= P(A) + P(B)

P(A and B)= P(A) x P(B)

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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TABLE A Areas Under the Normal Curve[a]

$\frac{X_i - \mu}{\sigma}$	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00
−3.5	0.00017	0.00017	0.00018	0.00019	0.00019	0.00020	0.00021	0.00022	0.00022	0.00023
−3.4	0.00024	0.00025	0.00026	0.00027	0.00028	0.00029	0.00030	0.00031	0.00033	0.00034
−3.3	0.00035	0.00036	0.00038	0.00039	0.00040	0.00042	0.00043	0.00045	0.00047	0.00048
−3.2	0.00050	0.00052	0.00054	0.00056	0.00058	0.00060	0.00062	0.00064	0.00066	0.00069
−3.1	0.00071	0.00074	0.00076	0.00079	0.00082	0.00085	0.00087	0.00090	0.00094	0.00097
−3.0	0.00100	0.00104	0.00107	0.00111	0.00114	0.00118	0.00122	0.00126	0.00131	0.00135
−2.9	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0017	0.0018	0.0019
−2.8	0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026
−2.7	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035
−2.6	0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047
−2.5	0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062
−2.4	0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082
−2.3	0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107
−2.2	0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139
−2.1	0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179
−2.0	0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228
−1.9	0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287
−1.8	0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359
−1.7	0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446
−1.6	0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548
−1.5	0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668
−1.4	0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808
−1.3	0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968
−1.2	0.0895	0.1003	0.1020	0.1038	0.1057	0.1075	0.1093	0.1112	0.1131	0.1151
−1.1	0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357
−1.0	0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587
−0.9	0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841
−0.8	0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119
−0.7	0.2148	0.2177	0.2207	0.2236	0.2266	0.2297	0.2327	0.2358	0.2389	0.2420
−0.6	0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743
−0.5	0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085

TABLE A (Continued)

$\frac{X_i - \mu}{\sigma}$	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00
−0.4	0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446
−0.3	0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821
−0.2	0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207
−0.1	0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602
−0.0	0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000

$\frac{X_i - \mu}{\sigma}$	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
+0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
+0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
+0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
+0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
+0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
+0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
+0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
+0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
+0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8079	0.8106	0.8133
+0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
+1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
+1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
+1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
+1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
+1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
+1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
+1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
+1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
+1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
+1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
+2.0	0.9773	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
+2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
+2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
+2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
+2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
+2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
+2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
+2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
+2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
+2.9	0.9981	0.9982	0.9983	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
+3.0	0.99865	0.99869	0.99874	0.99878	0.99882	0.99886	0.99889	0.99893	0.99896	0.99900
+3.1	0.99903	0.99906	0.99910	0.99913	0.99915	0.99918	0.99921	0.99924	0.99926	0.99929
+3.2	0.99931	0.99934	0.99936	0.99938	0.99940	0.99942	0.99944	0.99946	0.99948	0.99950
+3.3	0.99952	0.99953	0.99955	0.99957	0.99958	0.99960	0.99961	0.99962	0.99964	0.99965
+3.4	0.99966	0.99967	0.99969	0.99970	0.99971	0.99972	0.99973	0.99974	0.99975	0.99976
+3.5	0.99977	0.99978	0.99978	0.99979	0.99980	0.99981	0.99981	0.99982	0.99983	0.99983

[a]Proportion of total area under the curve that is under the proportion of the curve from $-\infty$ to $(X_i - \mu)/\sigma$ (X_i represents any desired value of the variable X).

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			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

TABLE 7-1 Suggested r Values for the Number of Streams

Number of Streams	r
2	9
3	7
4	6
5–6	5
7–10	4
11–27	3
Over 27	2