BITS Pilani
Dubai Campus

FIRST SEMESTER 2013- 2014

IV Year MECH/ CHE ME C443/ ME F443 Quality control, Assurance & Reliability Compre Date: 07.01.14
Weightage:40% Marks: 80 Time: 3 h

Answer all questions (8x10=80 Marks)

Assume suitable data if required

1. The experimental results for electro discharge machining process are given below. The parameters considered are pulse on time, Gap current, Pulse current and charge voltage. The output is hole diameter produced during machining in mm. Diameter should be as close as possible. Determine the optimum level for each parameter considered for the study using taguchy's technique.

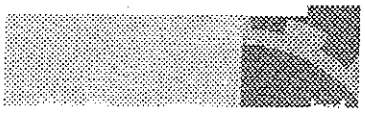
Expt. No.	Pulse-On Time	Gap Current	Pulse current	Charge voltage	Trial 1	Trial 2	Trial 3
1	P1	G1	B1	V1	8.90	8.91	8.92
2	P1	G2	B2	V2	8.80	8.82	8.84
3	P1	G3	B3	V3	8.90	8.93	8.96
4	P2	G1	B2	V3	8.70	8.71	8.72
5	P2	G2	B3	V1	8.60	8.62	8.64
6	P2	G3	B1	V2	8.70	8.74	8.78
7	P3	G1	B3	V2	8.50	8.51	8.52
8	P3	G2	B1	V3	8.50	8.55	8.60
9	P3	G3	B2	V1	8.50	8.55	8.60

2. Construct the ATI curve for the following single sampling plan: N=10000; n=52 and c=3.

3. A sequential sampling plan is to be used. It is desirable to have a producer's risk of 0.05 at AQL=0.01 and a consumer's risk of 0.1 at LTPD=0.1. Determine the boundaries for acceptance and rejection. For the following inspection results, determine the decision to be taken on lot: n=100, c=4 & n=200, c=7.

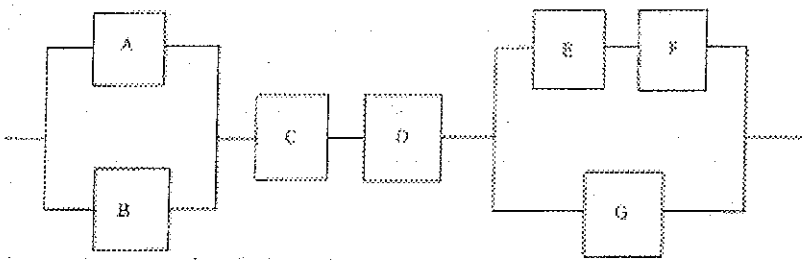
4. Construct a control chart for the following data related to valves in the production line and state whether the process in under control or not. Take sample size as 15 and sigma level as 2 for control limits.

Sample	Number Defective	Sample	Number Defective
1	3	6	2
2	1	7	0
3	0	8	3
4	0	9	1
5	0	10	0



5. A sample of 12 electronic components is tested for 1000h with no replacement of failed components. The time to failure is exponentially distributed. 3 components failed in the prescribed test time, the failure times being 650, 680, and 720h. Estimate the mean time to failure and failure rate. Find the 90% confidence interval for the mean time to failure.

6. Consider a 7 component system shown in fig. Assume the time to failure for each component has an exponential distribution. The failure rates are as follows: A =B =0.0005/h, C=0.0003/h, D=0.0008/h, E=0.0004/h, F=0.006/h, G=0.0064/h. Find the reliability of the system for 100h. What is the mean to failure of the system? If you are asked to improve the reliability of the system by just changing two components which two you would prefer? Why?



7. The diameter of the forged part has specifications of 120±5 mm. A sample of 25 parts chosen from the process gives a sample mean of 122mm with a sample standard deviation of 2mm. Find the process capability index assuming the process is not centered. Parts with a diameter less than the lower limit may cost $1 loss whereas diameter over upper limit may cost $0.5 loss. If the daily production rate is 100000 parts what is the daily loss in the current setting? If the process is centered, how much you can save?

8. For the above problem in Q7, determine the time interval for false alarm assuming ±2.5σ limits. If the mean is shifted to 123mm due to some problem, how long (samples) it will take to detect the change?

BITS Pilani
Dubai Campus

Cumulative poisson's distribution table

x	σ 0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
0	0.6065	0.3679	0.2231	0.1353	0.0821	0.0498	0.0302	0.0183	0.0111	0.0067
1	0.9098	0.7358	0.5578	0.4060	0.2873	0.1991	0.1359	0.0916	0.0611	0.0404
2	0.9856	0.9197	0.8088	0.6767	0.5438	0.4232	0.3208	0.2381	0.1736	0.1247
3	0.9982	0.9810	0.9344	0.8571	0.7576	0.6472	0.5366	0.4335	0.3423	0.2650
4	0.9998	0.9963	0.9814	0.9473	0.8912	0.8153	0.7254	0.6288	0.5321	0.4405
5	1.0000	0.9994	0.9955	0.9834	0.9580	0.9161	0.8576	0.7851	0.7029	0.6160
6	1.0000	0.9999	0.9991	0.9955	0.9858	0.9665	0.9347	0.8893	0.8311	0.7622
7	1.0000	1.0000	0.9998	0.9989	0.9958	0.9881	0.9733	0.9489	0.9134	0.8666
8	1.0000	1.0000	1.0000	0.9998	0.9989	0.9962	0.9901	0.9786	0.9597	0.9319
9	1.0000	1.0000	1.0000	1.0000	0.9997	0.9989	0.9967	0.9919	0.9829	0.9682
10	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9990	0.9972	0.9933	0.9863
11	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9991	0.9976	0.9945
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9992	0.9980
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9993
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9998
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999
16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Cumulative normal distribution table

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
-0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Chi-square distribution table

df	$\chi^2_{.995}$	$\chi^2_{.990}$	$\chi^2_{.975}$	$\chi^2_{.950}$	$\chi^2_{.900}$	$\chi^2_{.100}$	$\chi^2_{.050}$	$\chi^2_{.025}$	$\chi^2_{.010}$	$\chi^2_{.005}$
1	0.040	0.030	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188

BITS Pilani
Dubai Campus

FIRST SEMESTER 2013- 2014

IV/III Year Mechanical ME C443/ ME F443 Quality control, Assurance & Reliability Test 2 Open book
Date: 08.12.13 Weightage: 20% Marks: 40 Time: 50 min.

Answer all questions
Assume suitable data if required

Q1	A smoke detector may not work due to the following: *Smoke is not present in the smoke chamber; Smoke is not detected by the sensor; Alarm is not sounding* The smoke is absent due to the following processes: *The vent carrying the smoke to chamber is blocked due to paint or dust* The sensor cannot detect the smoke in the following situations: *Defective control box; No power to the sensor* The Alarm may not sound due to the following: *No power; Faulty alarm* *A standby battery is available to support the main supply of the alarm.* The faults in alarm are due to *broken solder joint or broken wire* Construct the fault tree for the case.	8
Q2	Assume 0.02 as probability for each base event and determine the top event probability **for Q1.** Construct the equivalent reliability diagram for the fault tree **of Q1.**	8
Q3	The standard shaft diameter is given by 25±1mm. The sample size for inspection is 50. The process mean of shafts is 25mm and the standard deviation is 2mm. The process mean is shifted to 28mm after a period of time. Determine how many samples will be inspected before detecting the change in the process.	8
Q4	The desired characteristics for a pen are Smooth in writing (I), writes for longer time (II); Feels good in hand (III); Not easy to lose (IV); cost (V); The importance weight for I, II and III characteristics is 4 whereas the importance weight for IV and V is 2. The features to be added to satisfy the above characteristics are as follows: body design (A); colour (B); lead quality (C); body material (D); The features are related to characteristics as below: High (score = 5): I & II with C; III with A Medium (score =3): III with B; IV with A Low(Score =1): V with A, C & D Determine the weighted absolute sore and corresponding relative score for the features and write your inference using QFD.	8
Q5	Consider a single sampling plan with n=100 and c=5. Determine the average outgoing quality limit if the defective items are not replaced during inspection. The lot size is very much greater than sample size.	8

BITS Pilani
Dubai Campus

FIRST SEMESTER 2013- 2014

IV Year Mechanical ME C443/ ME F443 Quality control, Assurance & Reliability Test 1 Date: 10.10.13
Weightage: 25% Marks: 25 Time: 50 min.

Answer all questions (5x5=25 Marks)

Q1. Determine the control limits and center line for the control charts to be used for the following data related to yield of a chemical process.

Sample	Obs 1	Obs 2	Obs 3	Obs 4	Obs 5	Avg	Range
1	10.68	10.689	10.776	10.798	10.714	10.732	0.116
2	10.79	10.86	10.601	10.746	10.779	10.755	0.259
3	10.78	10.667	10.838	10.785	10.723	10.759	0.171
4	10.59	10.727	10.812	10.775	10.73	10.727	0.221
5	10.69	10.708	10.79	10.758	10.671	10.724	0.119
6	10.75	10.714	10.738	10.719	10.606	10.705	0.143
7	10.79	10.713	10.689	10.877	10.603	10.735	0.274
8	10.74	10.779	10.66	10.737	10.822	10.748	0.162
9	10.77	10.773	10.641	10.644	10.725	10.710	0.132
10	10.72	10.671	10.708	10.85	10.712	10.732	0.179

Q2. The data related to number of dis-satisfied customers from a hospital is shown below:

sample	1	2	3	4	5	6	7	8	9	10
n	150	100	100	150	200	150	150	100	200	150
D	12	14	14	10	10	12	10	8	10	10

n- number of people visited, D – number of people not satisfied.
Determine the center line and control limits for the chart to be used.

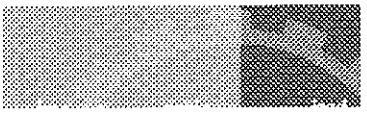
Q3. The average bursting strength of glass containers produced from 2 processes are listed below. The QC department wanted to check the *process performance*. Which process is more capable to meet the specifications 250±50 psi? How much % rejection is expected on both the processes?

Process	Mean	Standard deviation
A	264.06	32.02
B	244.06	29.56

Q4. A. Construct a fishbone diagram for the error free documentation of a publishing department. Take the major causes as personnel, environment, equipment and procedures. Add at least 5 sub factors for each factor.

Q5. The number of process errors in 10 shifts for two different processes for same application is presented in the following table. Construct the box plots for the data and compare them based on box plot characteristics.

Process A	12	15	23	24	30	31	33	36	50	73
Process B	2	3	6	8	13	14	19	23	60	69



BITS Pilani
Dubai Campus

ME C443/ ME F443 QUALITY CONTROL ASSURANCE & RELIABILITY

TEST 1 SOLUTIONS

A-1

Averages	X:10.733	R: 0.178
A2	D3	D4
0.58	0	2.11

Xbar chart:	**Rbar chart:**
UCL: 10.836; LCL: 10.629	UCL: 0.375 ; LCL: 0

[5]

A-2

P- chart

Day	1	2	3	4	5	6	7	8	9	10
n	150	100	100	150	200	150	150	100	200	150
D	12	14	14	10	10	12	10	8	10	10
p	0.080	0.140	0.140	0.067	0.050	0.080	0.067	0.080	0.050	0.067
pbar	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
UCL	0.141	0.155	0.155	0.141	0.132	0.141	0.141	0.155	0.132	0.141
LCL	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.004	0.000

[5]

A-3

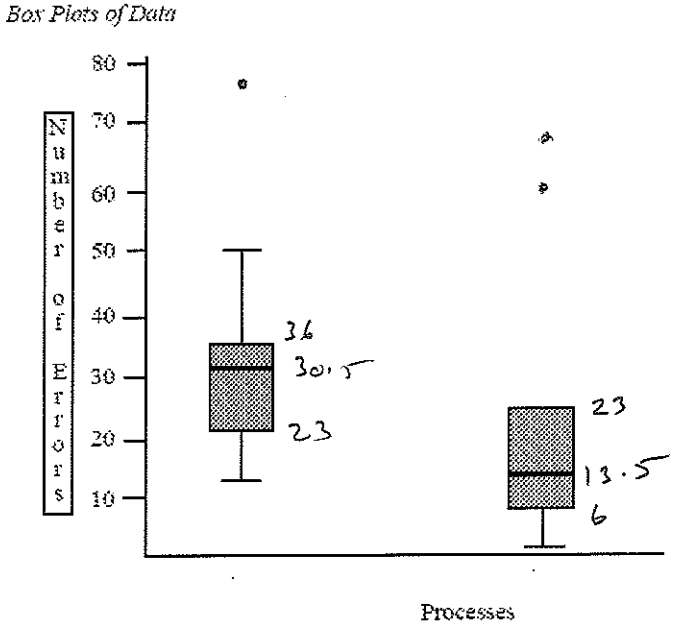
Cpk:

A	0.667 0.37 ✓	Z1: 1.13 Z2:-2	15% ✓
B	0.506 ✓ 0.63	Z1: 1.19 Z2:-1.48	10% ✓

[5]

BITS Pilani
Dubai Campus

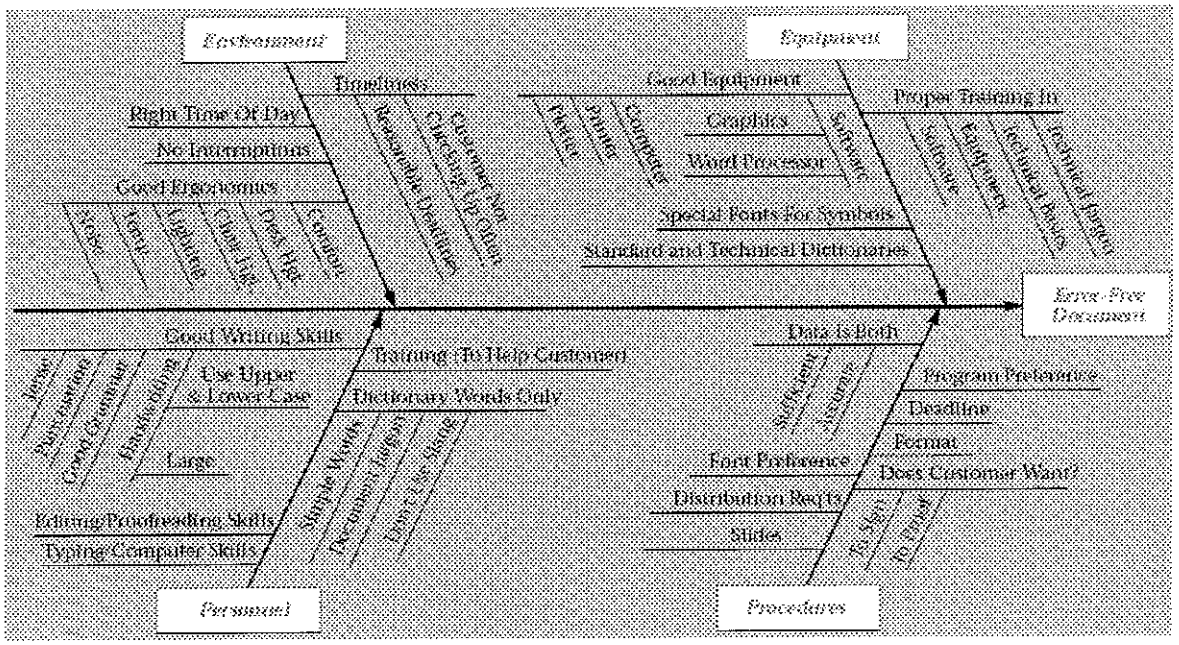
A-5



[5]

Characteristics: Centrality, Skewness, Dispersion and Length of tail

A-4.



[5]

BITS Pilani
Dubai Campus

FIRST SEMESTER 2013- 2014

ME C443/ ME F443 Quality control, Assurance & Reliability Quiz 1

Name: ID No. Date: 26.9.13

Time: 20 min. Marks: 16 Weightage: 8%

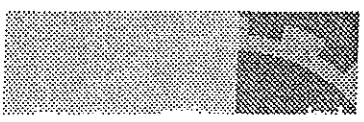
1. Construct a pareto chart for the following data based on cost [3]

Type of failure	Frequency	Cost of repair, $ Per failure
A	12	20
B	32	30
C	22	25
D	4	120

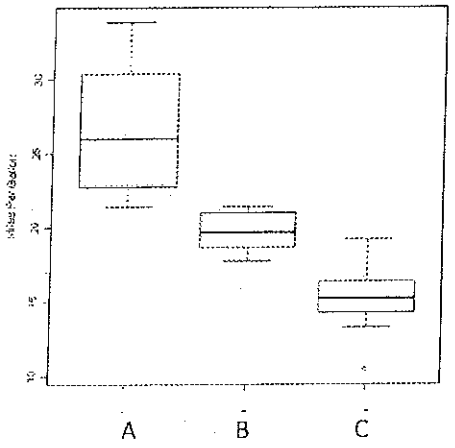
2. Construct a histogram for the following data and classify the students as A,B and C grades [3]

Marks out of 25	5,6,6,7,11,13,15,15,20,20,21

3 Mention the characteristics of common causes. (4 points) [2]

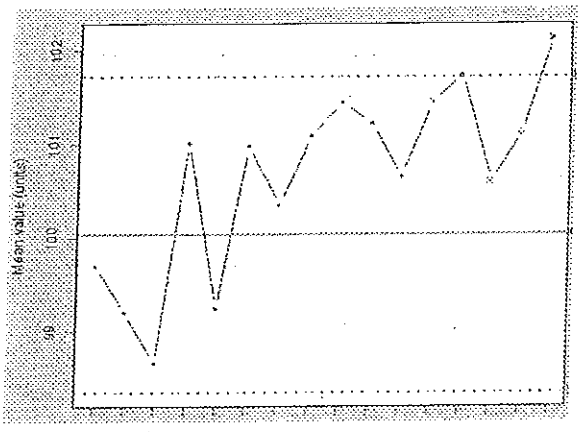


4. Compare the cars based on the box plot characteristics. [3]



A	B	C

5. Determine the number of runs in the chart using both the methods (work out on the chart to show the runs). [3]



6. List two advantages of fishbone diagram [2]