BITS, PILANI – DUBAI

First Semester 2009-2010

IV Year Mechanical
ME C443 Quality control, Assurance & Reliability **Comprehensive Exam**
Date: 29-12-09 **Weightage: 40%**
Time: 3 Hrs. **Marks: 80**

1. Answer all the questions
2. Assume relevant data if required.
3. Statistical table are permitted

SNo.

Marks

1

The data related to waiting time is summarized: $\sum_{i=1}^{25} \bar{X} = 1000$ minutes ; $\sum_{i=1}^{25} \bar{R} = 250$ minutes; number of samples =25; sample size=4; Find the control limits for $\bar{X}$ and $\bar{R}$ charts. Find the percentage of customers who will not have to wait more than 50 minutes assuming the process in control and the distribution of waiting time is normal. — 8

2

In a factory producing spark plug the number of defectives found in inspection of 20 samples of 100 each is given below:

Sample No.	Defectives	Sample No.	Defectives
1	5	11	4
2	10	12	7
3	12	13	8
4	8	14	3
5	6	15	3
6	4	16	4
7	6	17	5
8	3	18	8
9	3	19	6
10	5	20	10

Determine the control limits and state whether the process is in control. — 8

3

The temperature data recorded for a chemical process is given below. The temperature should lie between 65 and 85°C.

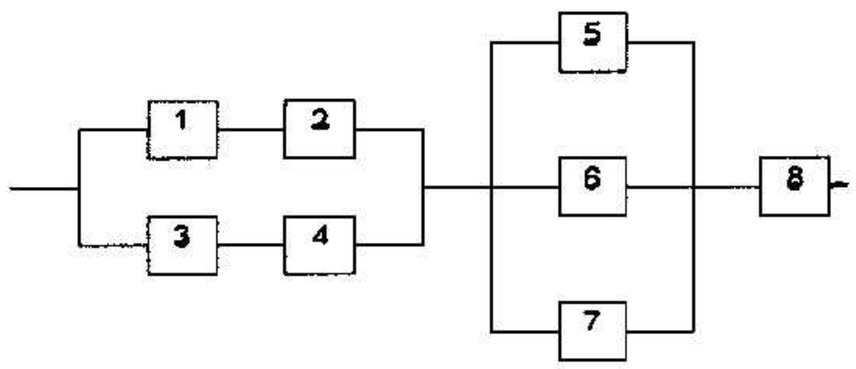
Temperature°C	60	78	70	84	81	80	85	60	88	75

Find the process capability index Cp and interpret the result. — 8

4

Determine AOQ values for the sampling plan N=2000, n=50 and c=2. Determine the AOQL considering p values from 0.02 to 0.20 in the increment of 0.02. — 8

(P-t-o)

5	Find a single sampling plan that satisfies the producer's risk of 5% for the lots which are 1.5% non-conforming. Considering c=1,3 and 6 design the plan and construct the OC curve for the most economical plan.	8
6	Find the system reliability and the mean time to failure for the system given below. The reliability & failure rates for the 8 components are as follows: | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | λ | 0.0002 | 0.002 | 0.0002 | 0.002 | 0.005 | 0.005 | 0.005 | 0.003 | | R | 0.92 | 0.90 | 0.88 | 0.96 | 0.95 | 0.95 | 0.92 | 0.93 |  	8
7	A fire safety sprinkler system is supplied with water through three pumps powered by an engine. The three pumps are connected to the sprinkler system through a common valve. Construct the fault tree diagram, reliability block diagram and determine the system reliability expression.	8
8	| Treatment | I | II | III | | 1 | 4 | 6 | 7 | | a | 8 | 14 | 13 | | b | 16 | 10 | 13 | | ab | 10 | 7 | 8 | | c | 18 | 24 | 27 | | ac | 32 | 26 | 30 | | bc | 34 | 42 | 44 | | abc | 23 | 20 | 22 | The results of a 2^3factorial design experiment are shown in the table. Find the main effects and the interaction effects for the data. Using ANOVA table, determine the most significant effect. Also form the regression equation for the response.	12
9	| A | B | C | D | Response | | | 1 | 1 | 1 | 3.5 | | 1 | 2 | 2 | 2 | 14.3 | | 1 | 3 | 3 | 3 | 8.8 | | 2 | 1 | 2 | 3 | 2.6 | | 2 | 2 | 3 | 1 | 16.5 | | 2 | 3 | 1 | 2 | 0.8 | | 3 | 1 | 3 | 2 | 3 | | 3 | 2 | 1 | 3 | 9.4 | | 3 | 3 | 2 | 1 | 4.5 | The table shows the input parameters and response obtained using an experiment based on taguchi technique. Determine the main effects of the parameters and find out the optimum levels of the parameters with an objective of minimum is better.	12

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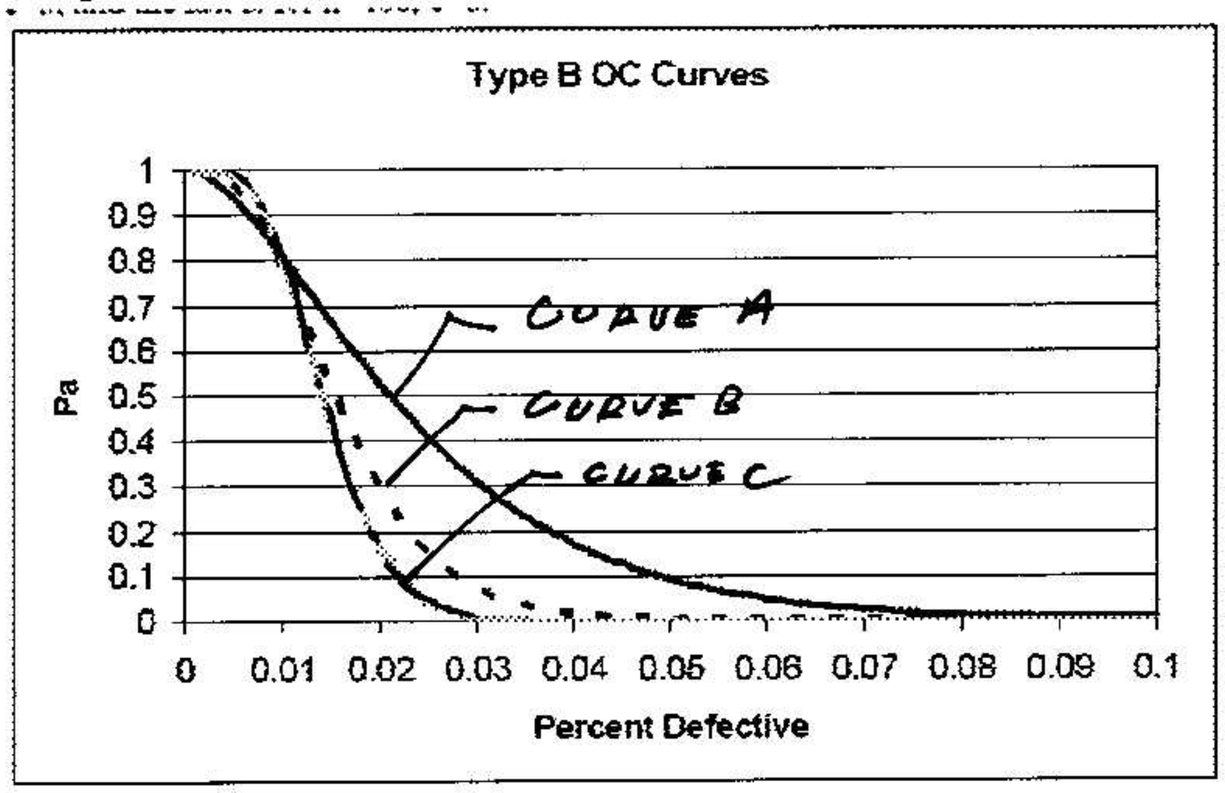
ME C443 Quality control, Assurance & Reliability **Test 2 (Open book)**
Date: 16-12-09 **Weightage: 20%**
Time: 50 min. **Marks: 40**

SNo.	**1. Answer all the questions** **2. Text book, statistical tables and class notes are permitted** **3. Use graph sheet for Q1.**	**Marks**
1	(a) Find a single sampling plan that has a producer's risk of 5% at a production defective rate of 1% and a consumer's risk of 10% at a production defective rate of 3%. Present your sampling plan in terms of sample size and acceptance number. (b) Plot a type B OC curve out to 5%, increasing by increments of 0.1%, defective for the plan established in part (a). Give probability of acceptance at a quality level of 0.040. (c) Label the producer's risk and consumer's risk described in part (a) on your OC curve. (d) Assuming screening of bad product, what is the worst average outgoing level which will occur with this sampling plan?	**15**
2	Below are three Type B OC Curves. One is for plan n=80, c=1; another is for n=240, c=3; and the last is for n=480, c=6. (a) Which curve belongs to which plan? (b) Which of the 3 plans above is the most economical in order to obtain a consumer's risk of < 10% at p = 0.03 and producer's risk of < 5% at p= 0.005?	**5**



3	Find a time terminated life testing plan that rejects lots with a mean life of 1200h with probability of 0.05 and accepts lots with a mean life of 350h with a probability of 0.10. Items are not replaced.	**5**
4	A life testing plan is to be terminated upon occurrence of the sixth failure. The plan should accept a lot having an acceptable mean life of 1100h with a probability of 0.95. 20 items are placed on test. The six failures occur at the following times: 480, 530, 600, 640 and 670. Failure items are replaced. Determine whether the lot should be accepted.	**5**
5	Assume that a system has six failure modes: A, B, C, D, E and F. Furthermore, assume that failure of the entire system will occur if mode A occurs or modes B and C occur simultaneously or if modes D, E and F occur simultaneously. Construct the reliability block diagram for the above and determine the system reliability.	**10**

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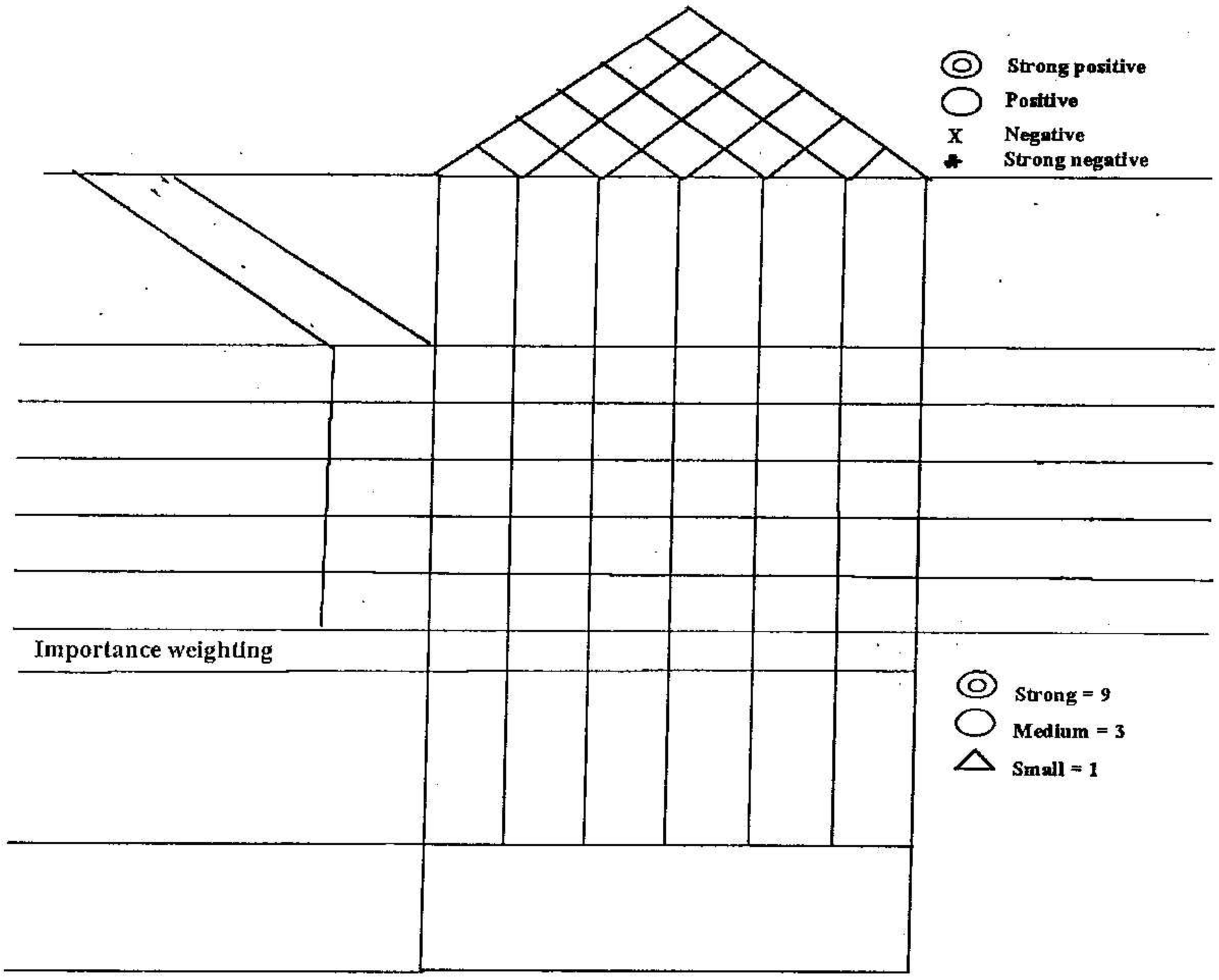
ME C443 Quality control, Assurance & Reliability **Test 1**
Date: 01-11-09 **Weightage: 25%**
Time: 50 min. **Marks: 50**

#	1. Answer all the questions 2. Return the HOQ sheet with answer script 3. Appendices A3 & A7 from TB are permitted	Marks
1	Estimate the centre and control limits for the construction of X bar and R bar charts using the following data (charts are not needed). OBSERVATIONS (SLIP- RING DIAMETER, cm) *#	1	2	3	4	5	xbar	Rbar* 1 | 5.02	5.01	4.94	4.99	4.96	4.98	0.08 2 | 5.01	5.03	5.07	4.95	4.96	5.00	0.12 3 | 4.99	5.00	4.93	4.92	4.99	4.97	0.08 4 | 5.03	4.91	5.01	4.98	4.89	4.96	0.14 5 | 4.95	4.92	5.03	5.05	5.01	4.99	0.13 6 | 4.97	5.06	5.06	4.96	5.03	5.01	0.10 7 | 5.05	5.01	5.10	4.96	4.99	5.02	0.14 8 | 5.09	5.10	5.00	4.99	5.08	5.05	0.11 9 | 5.14	5.10	4.99	5.08	5.09	5.08	0.15 10 | 5.01	4.98	5.08	5.07	4.99	5.03	0.10 *Sum 50.09 1.15*	**10**
2	Data for the number of dis-satisfied customers in a hospital observed for 20 samples of size 300 is shown in the table. Identify a suitable control chart and calculate the centerline and control limits for the data given below. (charts are not needed). \# 1 2 3 4 5 6 7 8 9 10 Un satisfied 9 11 7 8 5 12 14 9 7 7 # 11 12 13 14 15 16 17 18 19 20 Un satisfied 8 17 8 6 9 5 12 9 7 8	**10**
3	The diameter of a part has to fit an assembly. The specifications for the diameter are 6 ± 0.015 cm. The samples taken from the process in control yield a sample mean $\bar{X}$ of 5.99 cm and a sample standard deviation s of 0.008 cm. Find the natural tolerance limits of the process. Would you consider adjusting the process center?	**10**
4	The specifications for the diameter of shaft are 80 ± 3 mm. A random sample of 10 [illegible] gave the following observations for the diameters (in mm): 77, 79, 77, 81, 82, 79, 80, 78, 79, 78 Calculate the Cp index and comment. Assuming the distribution of the characteristic to be normal, estimate the proportion of the product that will be nonconforming. What measure would you take to improve conditions?	10

(P-t-O)

5	Fill the data given below (related to car door) in the house of quality and calculate the importance weighting and rank them accordingly. *Submit the house of quality sheet along with answer script.* <u>Requirements (with importance):</u> 1. Easy to close (7) 2. Stays open on a hill (5) 3. Easy to open (3) 4. Doesn't leak in rain (3) 5. No road noise (2) <u>Properties affecting the requirements (with importance):</u> 1. Energy needed to close (10) 2. Door seal resistance (6) 3. Check force on level ground (6) 4. Energy needed to open (9) 5. Acoustic transmission through window (2) 6. Water resistance (3) <u>Interaction between properties:</u> Negative for 1&2, 1&3, 1&5, 3&5, 4&5 Positive for 2&4, Strong positive for 1&4, 2&6 Strong negative NIL <u>Interaction between requirements & properties:</u> Strong: 1&1, 2&3, 3&4, 4&2, 4&6 Medium: 1&2, 3&2, 5&2 Weak: : NIL	**10**

House of Quality (HOQ)



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MEC 443 Quality Control, assurance & Reliability **Quiz 1** **A**

Marks: 8x2 =16 **Time: 20 min.**

Name: **ID No.:** **Date: 19.10.09**

1. Differentiate specifications and standards.
2. Name the type of quality costs for the following.
   i. Scrap ii. Calibration and maintenance iii. Warranty charges
   iv. Manufacturing failures
3. What is the use of pareto diagram?
4. Why is six sigma quality emphasized? (quantitative response is expected)
5. List the various phases for the use of QFD
6. Mention the benefits of fishbone diagram
7. In QFD, what is referred as roof of quality house?
8. Mention the components of quality triology.

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MEC 443 Quality Control, assurance & Reliability **Quiz 2** **A**

Marks: 7x2 =14 **Time: 20 min.**

Name: **ID No.:** **Date: 7.12.09**

1. Define AQL & LTPD
2. Construct OC curves showing the effect of sample size
3. Enumerate the procedure for double sampling plan with a ray diagram
4. How will you calculate ATI?
5. How will you evaluate the system reliability for redundant/ standby system?
6. Construct the sequential reliability plan showing the details
7. Differentiate time terminated test and failure terminated test.