Indian Statistical Institute, Bangalore

M.S (QMS) First Year
First Semester - Statistical Process Control I

Final Exam Time: 3 hours Date: 02 November, 2015

Answer as many questions as you can. Maximum you can score is 50

1. Bath concentration are measured hourly in a chemical process. Data (in ppm) for the last 12 hours is given below. The process target is $\mu_0 = 175$ ppm [12]

   a. Estimate the process standard deviation?

   b. Construct a tabular cusum for the process to quickly detect a shift of about 1.5σ?

Hour	Bath Concentration
1	160
2	158
3	150
4	151
5	153
6	154
7	158
8	162
9	186
10	165
11	179
12	184

2. The xbar and R values for 20 samples of size five are shown below. [12]

Sample Number	xbar	R	Sample Number	xbar	R
1	549	2.5	11	547	2
2	548	2.1	12	545	3
3	548	2.3	13	549	3.1
4	551	2.9	14	552	2.2
5	553	1.8	15	550	2.3
6	552	1.7	16	548	2.1
7	550	2	17	556	1.9
8	551	2.4	18	546	1.8
9	553	2.2	19	550	2.1
10	556	2.8	20	551	2.2

   a. The specification on this product has been established as 550 ± 5. Compute the process capability indices?

   b. Construct a modified control chart to monitor the process such that Cpk will be maintained at 1.3?

3. [10]

a. Describe Repeatability and Reproducibility?

b. The *ANOVA* table computed based on the data collected for a measurement system study is given below. Estimate the Repeatability and Reproducibility? How much is the total Gauge R & R? Is the measurement system acceptable?

Source	DF	SS	MS	F	P	F crit
Part	9	99.017	11.00189	7.33	0.00	2.12
Operator	1	2.417	2.417	1.61	0.21	4.08
Interaction	9	5.417	0.601889	0.40	0.93	2.12
Error	40	60	1.5			
Total	59	166.851				

4. [12]

a. Explain the terms AQL, LTPD, Producer's risk and Consumer's risk?

b. Give formula for computing Average Outgoing Quality (*AOQ*) and Average Total Inspection *(ATI*) for single sampling plan?

c. Suppose that a product is shipped in lots of size N = 10000. The receiving inspection procedure used is single sampling with n = 50 and c = 2. Calculate probability of acceptance *Pa*, Average Outgoing Quality *AOQ* and Average Total Inspection *ATI* for the incoming fraction nonconforming p = 0.01, 0.02, 0.03, 0.04, 0.05 and 0.06 ?

5. [10]

a. Give switching procedure between normal, tightened and reduced inspection in MIL STD 105E?

b. A supplier ships a component in lots of size N = 3000. The *AQL* has been established for this product at 1%. Find normal, tightened and reduced single sampling plans for this situation from MIL STD 105E, assuming general inspection level II is appropriate?