

Indian Statistical Institute, Bangalore
MS (QMS) First Year
Second Semester - Advanced Statistical Process Control

Midterm Exam
Maximum marks: 50

Date: March 01, 2018
Duration: 3 hours

1. Suggest suitable process control method for each process type (with proper justification).
[5 x 2 = 10]

Sl. No.	Description	Product Chart
a)	Quality of product depends on skill and experience of operator	Discrete
b)	Product quality is maintained by a cutting tool. After few parts the cutting tool to the adjusted to maintain the dimension	Continuous
c)	Suggest the control chart when C_{pk} value > 2.5	Continuous
d)	6 parts are produced together every time in an Injection Moulding Operation	Discrete
e)	The raw material quality is critical for the output quality	Continuous

2. [5 + 5 = 10]

a) Describe the method of SPC implementation in a manufacturing process.

b) In a short run production system, a machine produces three similar parts having dimension 10 ± 0.5 , 8 ± 0.4 and 12 ± 0.7 respectively. Suggest a suitable control chart technique and calculate the control limit which ensure $C_{pk} \geq 1.33$ for all parts.

3. A machine has 4 heads. Samples of $n = 3$ were collected from each head and subgroup \bar{x} and R value are given for 10 such subgroups. Construct a group control chart and also comment about the process. [10]

Sample	Head							
	1		2		3		4	
	\bar{x}	R	\bar{x}	R	\bar{x}	R	\bar{x}	R
1	51	1	55	1	53	3	53	5
2	52	3	57	2	52	4	55	1
3	51	2	55	1	54	2	58	4
4	54	2	58	2	51	1	53	2
5	53	1	54	4	50	3	54	2
6	55	2	52	3	54	2	52	6
7	54	4	51	1	53	1	58	5
8	53	3	50	2	57	1	53	1
9	52	1	49	1	52	1	49	2
10	51	2	53	3	51	2	50	3

4. [2 + 2 + 2 + 4 = 10]

a) Define the need for multivariate process control.

b) Define phase I and phase II limit of Hotelling; T^2 control chart.

c) When T^2 control limits can be approximated to X^2 control chart.

d) Consider a T^2 control chart for monitoring $P = 6$ quality characteristics. Suppose that the subgroup size $n = 5$ and then were 25 subgroups available to estimate sample covariance matrix.

i) Find out phase II limit with $\alpha = 0.01$.

ii) Compare this limit with the X^2 limit.

5. A product has 2 quality characteristics. The nominal value of this quality characteristics and their sample covariance matrix have been determined from the analysis of 30 preliminary subgroups of size $n = 10$ as [5 + 5 = 10]

$$\bar{\bar{x}} \begin{bmatrix} 3.0 \\ 3.5 \end{bmatrix} \quad s = \begin{bmatrix} 1.40 & 1.02 \\ 1.02 & 1.35 \end{bmatrix}$$

a) Calculate the phase I limit with $\alpha = 0.01$.

b) Another 2 samples were collected, does the process is in statistical control.

Sample No.	\bar{x}_1	\bar{x}_2
1	2.4	3.0
2	3.1	3.7

6. [3 + 2 = 5]

a) State the procedure of pre-control chart technique assuming that the product characteristic is normally distributed and the natural tolerance ($\mu \pm 3\sigma$) coincide with the tolerance.

b) What will be the pre-control limit when $C_{pk} = 1.33$.