

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

Midterm Exam  
Maximum marks: 50

Date: September 06, 2018  
Duration: 2 hours

*Answer as many questions as you can. The maximum you can score is 50*

1. Check whether the following statements are true or false. Justify your answers in not more than 3 sentences. [10]
  - a. The lower control limit of a  $R$  chart is always zero
  - b. For monitoring attribute characteristic, control charts need to be constructed for both measure of central tendency and measure of variation
  - c. For individual  $x$  chart, the characteristic under study need to be normally distributed
  - d. There is no major difference between random and rational sub-grouping
  - e. The  $UCL$  of a  $\bar{x}$  chart can be  $\bar{\bar{x}} + 3\frac{\bar{s}}{c_4\sqrt{n}}$  where  $c_4$  is a control chart constant
  
2. Briefly explain the logic of  $u$  chart? Give step by step details of constructing  $u$  chart? [10]
  
3. The diameter of holes drilled is measured in consecutive order by an automatic sensor. The results of measuring 25 holes are in the following table [20]

Sample	Diameter	Sample	Diameter
1	9.94	14	9.99
2	9.93	15	10.12
3	10.09	16	9.81
4	9.98	17	9.73
5	10.11	18	10.14
6	9.99	19	9.96
7	10.11	20	10.06
8	9.84	21	10.11
9	9.82	22	9.95
10	10.38	23	9.92
11	9.99	24	10.09
12	10.41	25	9.85
13	10.36		

- a. Using all the data, construct the control charts for individual observations and moving ranges?

- b. Is the drilling process in statistical control? If not, assume assignable causes can be found, out-of-control points can be eliminated and revise the control limits? Construct the control chart and plot the in-control process data?
  - c. Estimate the process mean and standard deviation for the in-control process?
  - d. If the specification limits on diameter are  $10 \pm 0.50$ , compute the process capability indices  $C_p$  &  $C_{pk}$ ? What are your conclusions regarding the ability of the drilling process to produce items conforming to specification?
  - e. Assuming that if an item exceeds the upper specification limit it must be rejected and if it is below the lower specification limit it can be reworked, what percent rejection and rework is the process now producing?
4. The following are the numbers of defective solder joints found during successive samples of 500 solder joints [15]

Sample	No. of Defectives	Sample	No. of Defectives
1	96	12	57
2	86	13	55
3	116	14	88
4	89	15	91
5	96	16	64
6	60	17	54
7	72	18	74
8	76	19	71
9	69	20	55
10	74	21	80
11	54		

- a. Using all the data, construct a suitable control chart?
- b. Determine whether the process is in statistical control? If not, assume assignable causes can be found, out-of-control points can be eliminated and revise the control chart? Construct the control chart and plot the in-control process data?