2003 S8PM704: STATISTICAL QUALITY CONTROL

Time: 180 minutes Max marks:100

Use of statistical tables as well as SQC tables is permitted.
Graph sheets will be provided.
Assume suitable data where necessary and clearly mention the same.
Explain the steps involved, in case of numerical problems.

1)

a) Explain the Central Limit Theorem and its significance in Statistical Quality Control.
b) Explain the difference between Type I error and Type II error. How are they fixed while carrying out a statistical test of a hypothesis?
c) Discuss the concept of rational subgroups as explained by Shewhart. How can we make any process appear to be in statistical control just by stretching out the interval between observations in the sample?
d) Sketch the following types of patterns of variation on a Control Chart: (i) Cyclic (ii) Mixture (iii) Shift (iv) trend (v) Stratification or lack of variability.
e) Explain how the points are plotted and control limits determined for a standardised control chart for fraction nonconforming with varying sample sizes.
f) What are the actions you would recommend to take on a process, depending on whether it is capable or not and in control or not?
g) Describe a method for taking a random sample from a lot.
h) How is the reliability of a system determined from the reliability of its components?

(5 X 8 = 40 marks)

2)

a)

i) The marks obtained by 22 students in a class are: 46, 63, 33, 57, 62, 70, 56, 77, 61, 53, 40, 52, 70, 69, 60, 70, 81, 59, 57, 55, 73, and 58. Construct a box plot for this data.

(8 marks)

ii) For Class A with 8 students, the sample standard deviation of marks was 12 while it was 8 for class B with 11 students. Test the hypothesis that the variances of marks from the two classes are equal. Use a 10% level of significance.

(7 marks)

OR

b)

i) A random sample of 50 units is drawn every hour from a machine producing brass screws. From past records, it is known that an average of 2% of screws produced were defective. Determine the probability that the sample will contain at least one defective screw.

(7 marks)

ii) The average marks of a random sample of 10 students from a school was 55.7, with a sample standard deviation of 4.5. Determine a 90% confidence interval for the average mark of students from the school.

(8 marks)

3)

a) Average and Range Control charts are required to be maintained for the weight of LPG filled in cylinders by an automatic filling machine. A subgroup of 5 consecutively filled cylinders was taken every half hour and weighed separately. The sum of the averages of 25 subgroups was 380kg, while the sum of the ranges was 8.8kg.

i) Determine the Trial Control Limits, and the Natural Tolerance Limits assuming that all points were in control.

(10 marks)

ii) If the mean shifts by 0.15kg, what will be the average time before an out of control condition is signalled?

(5 marks)

OR

b)

i) Thirty observations on the thickness of an electronic chip are as follows:

Chip No	1	2	3	4	5	6	7	8	9	10
Thickness	12.0	11.9	12.1	12.0	12.4	12.2	12.2	11.9	11.9	12.1

Chip No	11	12	13	14	15	16	17	18	19	20
Thickness	12.1	12.4	12.1	12	12.1	12.4	12	12.2	11.8	11.8

Chip No	21	22	23	24	25	26	27	28	29	30
Thickness	12	11.9	12.2	12	11.9	12.2	12.3	11.8	11.9	12.2

Determine limits for a control chart for individual thickness and moving range. Are all points within control limits? Under what condition is this type of chart valid?

(10 marks)

ii) Control charts with three sigma limits for average and sample standard deviation with subgroup size 8 are maintained on the volume of medicine in millilitres filled in a bottle. The upper control limit is 104.1 and the lower control limit 98.2 for the average. The values of the average for the next two subgroups were 103.9 and 103.5. What can you say about the process? Explain why.

(5 marks)

4)

a)

i) The average rejection rate for a process of manufacturing plastic containers is 5%. It is planned to maintain an np chart with sample size 200 for this process. Suggest three sigma control limits for this chart. If the process has shifted to a rejection rate of 8%, what is the probability that this shift will be detected on the first subsequent sample? Use the Poisson approximation.

(10 marks)

ii) It is planned to implement a control chart for fraction nonconforming on a single spindle automat producing washers. What should be the minimum sample size, if it is desired to have a positive lower control limit? The average fraction nonconforming is 0.04, from past data.

(5 marks)

OR

b) In a company manufacturing automobiles, invoices are prepared by a clerk. There have been several customer complaints on incorrect invoices, and it was decided to implement a control chart on the process. Every day, the invoices are counter checked by a senior accountant and the number of clerical errors obtained after 10 days are as follows:

Day	1	2	3	4	5	6	7	8	9	10
No of invoices	48	42	54	50	46	33	48	56	40	47
Errors	1	3	4	3	3	3	2	5	5	3

Determine control limits and plot the control chart. Use variable control limits. Note that one invoice can have more than one error.

(15 marks)

5)

a)

i) Draw the AOQ curve and determine the AOQL for a single sample rectifying inspection plan with sample size 120 and acceptance number 2. The lot size is 1000.

(10 marks)

ii) A boiler is known to have a mean time between failures of 4500hours. What is the probability that the boiler will not fail within 10,000 hours of operation?

(5 marks)

OR

b)

i) An automobile manufacturer has adopted a policy of inspecting 5% of the lot size. The lot is rejected if any defective is found. Three different suppliers A, B & C submit in lots of 60, 160 and 300 respectively. Determine for each supplier the lot fraction defective for which 90% of the lots will be accepted and comment on the inspection policy. Poisson tables may be used.

(10 marks)

ii) Two hundred bulbs were tested to determine the failure rate. After 300h, four units failed at 120, 140, 260 and 290h. The failed units were not replaced. Assuming a constant failure rate, determine the mean life of the bulbs.

(5 marks)