

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 3409

I

Unique Paper Code : 2374000007

Name of the Paper : Statistical Techniques for Quality Control

Name of the Course : **B.Sc. (Hons.) Statistics (Generic Elective)**

Semester : V

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Six** questions in all.
3. **Q. No. 1** is compulsory.
4. Attempt **two** questions from **section A** and three question from **Section B**.
5. Use of simple calculator is allowed.
6. Required Statistical tables are attached with the paper.

1. (a) Explain rational sub-grouping and its role in control chart analysis. (7)

OR

Explain the difference between random causes and assignable causes. What part do they play in the operation and interpretation of Shewhart control chart?

P.T.O.

- (b) Define Quality. Discuss its concept, application, and importance in manufacturing processes.

(8)

OR

Introduce ISO quality standards and discuss their significance in establishing quality management systems.

Section A

2. (a) What are modified control limits? Explain how they are derived. Why it is required to construct modified control limits? (7)

- (b) Discuss and derive the construction of $\bar{X}$ and R control charts for controlling process average and process variability, when population parameters are both

(i) known and

(ii) unknown. (8)

3. (a) Discuss in detail the concept of Process Capability Analysis. (7)

- (b) 25 Samples of size $n = 5$ each are taken from a manufacturing process every hour. Assuming quality characteristic is normally distributed, $\bar{X}$ and R are computed for each sample. Given,

$$\sum_{i=1}^{25} \bar{X}_i = 662.5 \text{ and } \sum_{i=1}^{25} R_i = 9.0$$

- (i) Find the 3σ control limits for the $\bar{X}$ charts.
- (ii) If the specifications limits are 26.40 ± 0.50 , then estimate the fraction non-conforming, assuming that both charts exhibit control. (8)
4. (a) Explain sampling inspection plans for attributes. Define the OC and ASN function. (7)
- (b) Obtain the control limits for number of defects per unit; also obtain the control limits for average number of defects per unit giving clearly the statistical concept used? (8)

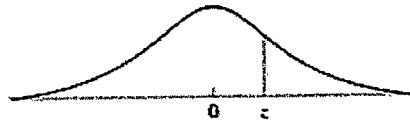
Section B

5. (a) What is an OC curve? Draw its important points on the plot. Obtain its expression in a single sampling plan. (7)
- (b) A process is being controlled with a fraction nonconforming control chart. The process average has been shown to be 0.07. Three-sigma control limits are used, and the procedure calls for taking daily samples of 400 items.
- (i) Calculate the upper and lower control limits.
- (ii) If the process average should suddenly shift to 0.10, what is the probability that the shift would be detected on the first subsequent sample? (8)

6. (a) Explain briefly the Process and Product control, detailing the roles of both in ensuring quality in manufacturing process. (7)
- (b) Define AOQ and AOQL. For a single sampling plan obtain an expression for AOQL. (8)
7. (a) Distinguish among natural tolerance limits, control limits and specification limits. Discuss the ideal situation? (7)
- (b) A lot consists of 1000 items, of which 100 are defective. Using a single sampling plan with a sample size of 50 and an acceptance number of 3, calculate the probability of accepting the lot. (8)
8. (a) Define Statistical Process control (SPC). Explain in brief the tools of Statistical Process control (SPC). (7)
- (b) A company manufactures four models of radios and receives quite a few complaints from customers. In order to improve the quality of radios, the management decides to use control charts technique for the defects observed at the final testing. The number of radios manufactured daily is not same.
- (a) Suggest an appropriate control chart for controlling the defects?
- (b) Set up the control limits giving clearly the assumptions made and the statistical concept used. (8)

Cumulative Standard Normal Distribution

$$\Phi(z) = \int_{-\infty}^z \frac{1}{\sqrt{2\pi}} e^{-u^2/2} du$$



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.50000	0.50399	0.50798	0.51197	0.51595	0.51994	0.52392	0.52790	0.53188	0.53586
0.1	0.53983	0.54379	0.54776	0.55172	0.55567	0.55962	0.56356	0.56749	0.57142	0.57534
0.2	0.57926	0.58317	0.58706	0.59095	0.59483	0.59871	0.60257	0.60642	0.61026	0.61409
0.3	0.61791	0.62172	0.62551	0.62930	0.63307	0.63683	0.64058	0.64431	0.64803	0.65173
0.4	0.65542	0.65910	0.66276	0.66640	0.67003	0.67364	0.67724	0.68082	0.68438	0.68793
0.5	0.69146	0.69497	0.69847	0.70194	0.70540	0.70884	0.71226	0.71566	0.71904	0.72240
0.6	0.72575	0.72907	0.73237	0.73565	0.73891	0.74215	0.74537	0.74857	0.75175	0.75490
0.7	0.75803	0.76115	0.76424	0.76730	0.77035	0.77337	0.77637	0.77935	0.78230	0.78523
0.8	0.78814	0.79103	0.79389	0.79673	0.79954	0.80234	0.80510	0.80785	0.81057	0.81327
0.9	0.81594	0.81859	0.82121	0.82381	0.82639	0.82894	0.83147	0.83397	0.83646	0.83891
1.0	0.84134	0.84375	0.84613	0.84849	0.85083	0.85314	0.85543	0.85769	0.85993	0.86214
1.1	0.86433	0.86650	0.86864	0.87076	0.87285	0.87493	0.87697	0.87900	0.88100	0.88297
1.2	0.88493	0.88686	0.88877	0.89065	0.89251	0.89435	0.89616	0.89796	0.89973	0.90147
1.3	0.90320	0.90490	0.90658	0.90824	0.90988	0.91149	0.91308	0.91465	0.91621	0.91773
1.4	0.91924	0.92073	0.92219	0.92364	0.92506	0.92647	0.92785	0.92922	0.93056	0.93189
1.5	0.93319	0.93448	0.93574	0.93699	0.93822	0.93943	0.94062	0.94179	0.94295	0.94408
1.6	0.94520	0.94630	0.94738	0.94845	0.94950	0.95053	0.95154	0.95254	0.95352	0.95448
1.7	0.95543	0.95637	0.95728	0.95818	0.95907	0.95994	0.96080	0.96164	0.96246	0.96327
1.8	0.96407	0.96485	0.96562	0.96637	0.96711	0.96784	0.96856	0.96926	0.96995	0.97062
1.9	0.97128	0.97193	0.97257	0.97320	0.97381	0.97441	0.97500	0.97558	0.97615	0.97670
2.0	0.97725	0.97778	0.97831	0.97882	0.97932	0.97982	0.98030	0.98077	0.98124	0.98169
2.1	0.98214	0.98257	0.98300	0.98341	0.98382	0.98422	0.98461	0.98500	0.98537	0.98574
2.2	0.98610	0.98645	0.98679	0.98713	0.98745	0.98778	0.98809	0.98840	0.98870	0.98899
2.3	0.98928	0.98956	0.98983	0.99010	0.99036	0.99061	0.99086	0.99111	0.99134	0.99158
2.4	0.99180	0.99202	0.99224	0.99245	0.99266	0.99286	0.99305	0.99324	0.99343	0.99361
2.5	0.99379	0.99396	0.99413	0.99430	0.99446	0.99461	0.99477	0.99492	0.99506	0.99520
2.6	0.99534	0.99547	0.99560	0.99573	0.99585	0.99598	0.99609	0.99621	0.99632	0.99643
2.7	0.99653	0.99664	0.99674	0.99683	0.99693	0.99702	0.99711	0.99720	0.99728	0.99736
2.8	0.99744	0.99752	0.99760	0.99767	0.99774	0.99781	0.99788	0.99795	0.99801	0.99807
2.9	0.99813	0.99819	0.99825	0.99831	0.99836	0.99841	0.99846	0.99851	0.99856	0.99861
3.0	0.99865	0.99869	0.99874	0.99878	0.99882	0.99886	0.99889	0.99893	0.99897	0.99900
3.1	0.99903	0.99906	0.99910	0.99913	0.99916	0.99918	0.99921	0.99924	0.99926	0.99929
3.2	0.99931	0.99934	0.99936	0.99938	0.99940	0.99942	0.99944	0.99946	0.99948	0.99950
3.3	0.99952	0.99953	0.99955	0.99957	0.99958	0.99960	0.99961	0.99962	0.99964	0.99965
3.4	0.99966	0.99968	0.99969	0.99970	0.99971	0.99972	0.99973	0.99974	0.99975	0.99976
3.5	0.99977	0.99978	0.99978	0.99979	0.99980	0.99981	0.99981	0.99982	0.99983	0.99983
3.6	0.99984	0.99985	0.99985	0.99986	0.99986	0.99987	0.99987	0.99988	0.99988	0.99989
3.7	0.99989	0.99990	0.99990	0.99990	0.99991	0.99991	0.99992	0.99992	0.99992	0.99992
3.8	0.99993	0.99993	0.99993	0.99994	0.99994	0.99994	0.99994	0.99995	0.99995	0.99995
3.9	0.99995	0.99995	0.99996	0.99996	0.99996	0.99996	0.99996	0.99996	0.99997	0.99997

Taken from a Book entitled "An introduction to SQC" by D.C. Montgomery

TABLE: FACTORS USEFUL IN THE CONSTRUCTION OF CONTROL CHARTS

Sample size	Mean chart			Standard deviation chart					Range chart				
	Factors for control limits			Factors for central line	Standard deviation chart				Factors for central line	Range chart			
n	A	A_1	A_2	c_2	B_1	B_2	B_3	B_4	d_2	D_1	D_2	D_3	D_4
2	2.121	3.760	1.886	0.5642	0	1.843	0	3.297	1.128	0	3.686	0	3.267
3	1.232	2.394	1.023	0.7236	0	1.858	0	2.568	1.693	0	4.358	0	2.575
4	1.500	1.880	0.729	0.7979	0	1.8080	0	2.266	2.059	0	4.698	0	2.282
5	1.342	1.596	0.577	0.8407	0	1.756	0	2.089	2.326	0	4.918	0	2.115
6	1.225	1.410	0.483	0.8686	0.026	1.711	0.030	1.970	2.534	0	5.078	0	2.004
7	1.134	1.277	0.419	0.8882	0.105	1.672	0.118	1.882	2.704	0.205	5.203	0.076	1.924
8	1.061	1.175	0.373	0.9027	0.167	1.638	0.185	1.815	2.847	0.387	5.307	0.136	1.864
9	1.000	1.094	0.337	0.9139	0.219	1.609	0.239	1.761	2.970	0.546	5.394	0.184	1.816
10	0.949	1.028	0.308	0.9227	0.262	1.584	0.284	1.716	3.078	0.687	5.469	0.223	1.777
11	0.905	0.973	0.285	0.9300	0.299	1.561	0.321	1.679	3.173	0.812	5.534	0.256	1.744
12	0.866	0.925	0.266	0.9359	0.331	1.541	0.354	1.646	3.258	0.924	5.592	0.284	1.716
13	0.832	0.884	0.249	0.9410	0.359	1.523	0.382	1.618	3.336	1.026	5.646	0.308	1.692
14	0.802	0.848	0.235	0.9453	0.384	1.507	0.406	1.594	3.407	1.121	5.693	0.329	1.671
15	0.775	0.816	0.223	0.9499	0.406	1.492	0.428	1.572	3.472	1.207	5.737	0.348	1.652
16	0.759	0.788	0.212	0.9523	0.427	1.478	0.448	1.552	3.532	1.285	5.779	0.364	1.636
17	0.728	0.762	0.203	0.9551	0.445	1.465	0.466	1.534	3.588	1.359	5.817	0.379	1.621
18	0.707	0.738	0.194	0.9576	0.461	1.454	0.482	1.518	3.640	1.426	5.854	0.392	1.608
19	0.688	0.717	0.187	0.9599	0.477	1.443	0.497	1.503	3.689	1.490	5.888	0.404	1.596
20	0.671	0.697	0.180	0.9619	0.491	1.433	0.510	1.499	3.735	1.548	5.922	0.414	1.586
21	0.655	0.679	0.173	0.9638	0.504	1.424	0.523	1.477	3.778	1.606	5.950	0.425	1.575
22	0.640	0.662	0.167	0.9655	0.516	1.415	0.534	1.466	3.819	1.659	5.979	0.434	1.566
23	0.626	0.647	0.162	0.9670	0.527	1.407	0.545	1.455	3.858	1.710	6.006	0.443	1.557
24	0.612	0.632	0.157	0.9684	0.538	1.399	0.555	1.445	3.895	1.759	6.031	0.452	1.548
25	0.600	0.610	0.153	0.9696	0.548	1.392	0.565	1.435	3.931	1.804	6.058	0.459	1.541

This table is taken from "Fundamental of Applied statistics" by Gupta and Kapoor