

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4814

E

Unique Paper Code : 32371403

Name of the Paper : Statistical Quality Control

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

Semester : IV

Duration : 3 hour

Maximum Marks : 75

Instructions for Candidates

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

1. (a) Define Statistical Process Control (SPC). Explain in brief the seven tools of SPC. (5)

OR

Discuss briefly the concept of DMAIC. Also discuss the Eight steps disciplined and structured approach of Six Sigma leading to a transactional six sigma success.

- (b) Explain the difference between random causes and special causes. What part do they play in the operation and interpretation of Shewhart control chart? (5)

P.T.O.

Section A

2. (a) Discuss and derive the construction of \bar{X} and s control charts for controlling process average and process variability, when population parameters are both (i) known and (ii) unknown. (6½)
- (b) A fraction non-conforming control chart has resulted in the following values : centre line = 0.01, UCL = 0.0399, LCL = -0.01795, and $n = 100$. If 3σ limits are used, find the smallest sample size that would yield a positive lower control limit. (6½)
3. (a) Discuss in detail the concept of Process Capability Analysis. (6½)
- (b) In a production process, \bar{X} -chart shows lack of control but the R-chart always shows control. The specification limits for certain dimensions are 3.51 ± 0.005 inches. The estimate of σ from the R-chart is 0.001. If target \bar{X} is 3.51 with a sub-group of size 4,
- (i) What should be the Upper control limit for \bar{X} chart?
- (ii) What should be the upper rejection limit on the \bar{X} chart? (6½)
4. (a) Discuss the construction of np-chart when all samples are of same size. How is the procedure modified for variable sample size? Discuss any two methods. (6½)
- (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.

- (i) Suggest an appropriate control chart for controlling the defects?
- (ii) Set up the control limits giving clearly the assumptions made and the statistical concept used. (6½)
5. (a) 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 suddenly shifts to 0.10, what is the probability that the shift would be detected on the first subsequent sample? (6½)
- (b) Describe the double sampling plan for attributes and obtain the expressions for producer's and consumer's risk. (6½)
6. (a) Distinguish between :
- (i) Flow Charts of (a) single sampling rectification plan and (b) double sampling rectification plan when a lot is rejected on the basis of first sample.
- (ii) ASN and ATI for single sampling plan. (6½):
- (b) Explain AOQ and AOQL. Plot AOQ curve and mark AOQL. Obtain an expression for AOQL for a single sampling plan. (6½)

Section B

7. (a) Describe the construction of index numbers on the basis of simple and weighted average of the price relatives. (6½)
- (b) Under what conditions will the Factor Reversal Test be satisfied by Laspeyre's Price Index Number. Also, explain Time Reversal Test. (6½)
8. (a) Explain the concept of (i) base shifting and (ii) splicing of index numbers mentioning their importance. (6½)
- (b) What is a Chain Index? Show that the chain indices are equal to the corresponding fixed base indices if the formula used satisfies the circular test. (6½)

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

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	0.99995	0.99996	0.99996	0.99996	0.99996	0.99996	0.99997	0.99997

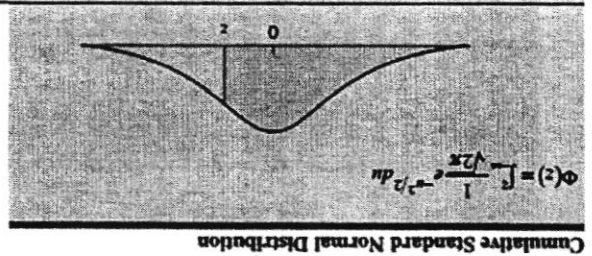


TABLE : FACTORS USEFUL IN THE CONSTRUCTION OF CONTROL CHARTS

Sample size	Mean chart			Standard deviation chart					Range chart				
	Factors for control limits			Factors for central line					Factors for central line				
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	1.668
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	9.9619	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