[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1936 **L**

Unique Paper Code : 2372012402

Name of the Paper : Total Quality Management

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

Semester : IV

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 **five** questions in all.
3. Q. No. **1** is compulsory.
4. Attempt **three** questions from **Section A** and **one** question from **Section B**.
5. Use of non-programmable calculator is allowed.
6. Required Statistical tables are attached with the paper.

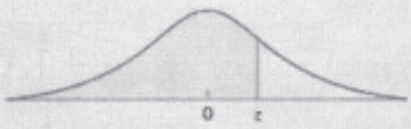
Q1(a)	i) Define Statistical Process Control (SPC). List seven tools of SPC. ii) What is AQL? Plot it on an appropriate graph. iii) Why is acceptance sampling preferred over 100% inspection or no inspection? iv) What is ISO? Name any two series of ISO.	3x4
(b)	i) Lower Modified control limit is given by an expression..... ii) Noise is a synonym of ..... whereas systematic error is also called ..... cause of variation. iii) The three approaches of lot sentencing are ... . , ... and ... . iv) Type I and type II errors in hypothesis testing are also called as ..... and ..... respectively in process control. v) Six Sigma is a measure of variation that represents ..... ppm. vi) When a lot is rejected in an acceptance rectification single sampling plan, the number of defectives left in a lot becomes	1 x 6
	Section A	
Q2(a)	Discuss in detail the concept of Process Capability Analysis.	9
(b)	Differentiate between revised control limits and rejection control limits, mentioning the need and development in each case.	9
Q3(a)	Assuming quality characteristic is a normally distributed variable measurable on a meter scale, 50 samples of size $n = 10$ each are taken from a manufacturing process. Discuss the construction of appropriate control chart to bring the process under statistical control.	9

(b)	If there are 40 samples of size n = 3 and each of them are taken from a manufacturing process where quality characteristic is normally distributed. Then, (i) Estimate the process standard deviation. (ii) Find the 3σ control limits for the $\bar{x}$ and R charts. (iii) If the specifications limits are 30 ± 1.0030, estimate the fraction nonconforming. Where, $$\sum_{i=1}^{40} \bar{x}_i = 1200, and \sum_{i=1}^{40} R_i = 20$$	9

Q4(a)	What are control charts for attributes? Derive control charts for proportion defectives for variable sample size using variable control limit and standardized control limit methods.	9
(b)	A chemical process requires temperature to be maintained between 100°C and 110°C. The process operates at a mean of 105°C with a standard deviation of 3°C. Then (i) Obtain the process capability index for this process and comment on the capability of the process. (ii) Find natural tolerance limits for the process. (iii) What change in σ is required to make Cp=1.33?	9
Q5(a)	What is meant by acceptance number (c)? Discuss the choice between single sampling plan and double sampling plan for attributes. Give at least three situations where one is superior to other.	9
(b)	Describe double sampling plan for attributes and obtain the expressions for Producer risk and Consumer risk. Also obtain the expression for ASN and ATI for its rectifying plan.	9
	Section B	
Q6(a)	What is Lean Manufacturing? Explain the various tools and techniques of Lean Manufacturing.	9
(b)	Discuss various Six Sigma training plans.	9
Q7(a)	Write the name of the four deliverables of the Define Phase and explain the key elements of a Six Sigma Project Charter.	9
(b)	Explain various tools that can develop creative solutions based on generating alternatives in the Improve Phase of DMAIC.	9

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	0.62276	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 form a Book entitled "An introduction to SQC" by D.C. Montgomery

P.T.O.

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

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	0.548	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	0348	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	0.0728	0.762	0.203	0.9951	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	6.173	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