BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BE **SEMESTER : V**
BRANCH: PRODUCTION **SESSION : MO/19**

SUBJECT: PE5005 STATISTICAL QUALITY CONTROL

TIME: 3 HOURS **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total the 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Define quality characteristics? What are the various types of quality characteristics? [2]

Q.1(b) Select a specific product or service and discuss how the eight dimensions of quality impact its overall acceptance by consumers. [4]

Q.1(c) The time to failure in hours of an electronic component subjected to an accelerated life test is shown in Table below. To accelerate the failure test, the units were tested at an elevated temperature. [6]

127	124	121	118	125	123	136	131	131	120
140	125	124	119	137	133	129	128	125	141
121	133	124	125	142	137	128	140	151	124
129	131	160	142	130	129	125	123	122	126

(a) Calculate the sample average and standard deviation. (b) Find the sample median.
(c) Construct a stem-and-leaf plot.

Q.2(a) The diameter of cotter pins produced by an automatic machine is a characteristic of interest. Based on historical data, the process average diameter is 15 mm with a process standard deviation of 0.8 mm. If samples of size 4 are randomly selected from the process: [4]
(a) What is the probability of a false alarm?
(b) If the process mean shifts to 14.5 mm, what is the probability of not detecting this shift on the first sample plotted after the shift? What is the ARL?

Q.2(b) The thickness of a printed circuit board is an important quality parameter. Data on board thickness (in inches) are given in Table for samples of three boards each. [8]
(a) Set up X-bar and *R* control charts. Is the process in statistical control?
(b) Estimate the process standard deviation.
(c) What are the limits that you would expect to contain nearly all the process measurements?
(d) If the specifications are at 0.0630 in. ±0.0015 in., what is the value of the process capability ratio *Cp*?

Sample Number	1	2	3	4	5	6	7	8	9	10
x1	0.0629	0.063	0.0628	0.0634	0.0619	0.0613	0.063	0.0628	0.0623	0.0631
x2	0.0636	0.0631	0.0631	0.063	0.0628	0.0629	0.0639	0.0627	0.0626	0.0631
x3	0.064	0.0622	0.0633	0.0631	0.063	0.0634	0.0625	0.0622	0.0633	0.0633

For sample size 3 A2=1.02, A3=1.934, d2=1.693, D3=00 , D4=2.57

Q.3(a) List Western Electric Rules for Shewhart Control Charts. [4]

Q.3(b) The number of nonconforming switches in samples of size 150 are shown in Table. [8]

Sample Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nonconforming Switches	8	1	3	0	2	4	0	1	10	6	6	0	4	0	3	1	15	2	3	0

i) Construct a fraction nonconforming control chart for these data.
ii) Does the process appear to be in control? If not, assume that assignable causes can be found for all points outside the control limits and calculate the revised control limits.
iii) Setup a np control chart (UCL, LCL & centre line) for switches.

Q.4(a) Discuss the advantages and limitations of sampling plans in terms of simplicity, administrative cost, number of items inspected, inspection cost and information content. [2]

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Q.4(b) What are the various Measures used to evaluate the goodness of a sampling plan? Briefly explain each of them. [4]

Q.4(c) Construct the AOQ curve for the sampling plan N lot size of 2000, sample size of 100, and acceptance number of 3. Calculate the AOQL. [6]

Q.5(a) Explain the switching rules for normal, tightened, and reduced inspection of MIL STD 105E? [2]

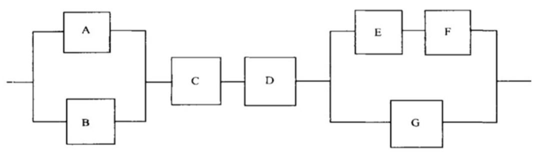
Q.5(b) A sampling plan is desired to have a producer's risk of 0.05 at AQL = 2.0% nonconforming and a consumer's risk of 0.10 at LQL = 7% nonconforming. Find the single sampling plan with the largest sample size. Find the single sampling plan with the smallest sample size. [4]

Q.5(c) Let's consider a double sampling plan of lot size 3000 given by the following parameters: n1=40, c1=1, r1=5, n2=80, c2=5, r2=6. For a lot proportion nonconforming value of p=0.05, find the probability of accepting such lots. [6]

Q.6(a) With the help of a diagram describe the life cycle of a product. [2]

Q.6(b) A transistor has an exponential time-to-failure distribution with a failure rate of 6% per 1000 hours. What is the reliability of the amplifier at 6000 hours? Find the mean time to failure. [4]

Q.6(c) Consider the seven-component system shown in Figure. Assume that the time to failure for each component has an exponential distribution. The failure rates are as follows: λ_A = 0.0005/hour, λ_B = 0.0005/hour, λ_C = 0.0003/h, λ_D = 0.0008/hour, λ_E = 0.0004/hour, λ_F = 0.006/hour, and λ_G = 0.0064/hour. Find the reliability ofthe system after 1000 hours. What is the mean time to failure of the system? [6]



Q.7(a) Define Quality circle. Explain its concept. [2]

Q.7(b) Define Six Sigma as Philosphy, performance Matric &methodology? [4]

Q.7(c) Discuss the 14 points of Deming philosophy for implementing quality and productivity improvement. [6]

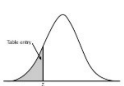


Table1: Standard Normal Probabilities

Table entry for z is the area under the standard normal curve to the left of z

Z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.10	0.00097	0.00094	0.00090	0.00087	0.00084	0.00082	0.00079	0.00076	0.00074	0.00071
-3.00	0.00135	0.00131	0.00126	0.00122	0.00118	0.00114	0.00111	0.00107	0.00104	0.00100
-1.70	0.04457	0.04363	0.04272	0.04182	0.04093	0.04006	0.03920	0.03836	0.03754	0.03673
-1.60	0.05480	0.05370	0.05262	0.05155	0.05050	0.04947	0.04846	0.04746	0.04648	0.04551
1.70	0.95543	0.95637	0.95728	0.95818	0.95907	0.95994	0.96080	0.96164	0.96246	0.96327
1.80	0.96407	0.96485	0.96562	0.96638	0.96712	0.96784	0.96856	0.96926	0.96995	0.97062
3.00	0.99865	0.99869	0.99874	0.99878	0.99882	0.99886	0.99889	0.99893	0.99896	0.99900
3.10	0.99903	0.99906	0.99910	0.99913	0.99916	0.99918	0.99921	0.99924	0.99926	0.99929
4.10	0.99998	0.99998	0.99998	0.99998	0.99998	0.99998	0.99998	0.99998	0.99999	0.99999
4.20	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999

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λ=np								
X	0.01	0.1	0.5	1	1.5	2	2.5	3
0	0.995	0.9048	0.6065	0.3679	0.2231	0.1353	0.0821	0.0498
1	1	0.9953	0.9098	0.7358	0.5578	0.406	0.2873	0.1991
2	1	0.9998	0.9856	0.9197	0.8088	0.6767	0.5438	0.4232
3	1	1	0.9982	0.981	0.9344	0.8571	0.7576	0.6472
4	1	1	1	0.996	0.981	0.947		0.815

X	3.5	4	4.5	5	6.5	7	7.5	8
0	0.0302	0.0183	0.0111	0.0067	0.0015	0.0009	0.0006	0.0003
1	0.1359	0.0916	0.0611	0.0404	0.0113	0.0073	0.0047	0.003
2	0.3208	0.2381	0.1736	0.1247	0.043	0.0296	0.0203	0.0138
3	0.5366	0.4335	0.3423	0.265	0.1118	0.0818	0.0591	0.0424
4	0.725	0.629	0.532	0.440	0.224	0.173	0.132	0.1

Table3: Value of np for a producers Risk of 0.05 and a consumers Risk of 0.10 (Grubbs table)

Acceptance number, c	Pa= 0.95, np1	Pa= 0.1, np2	np2/np1
1	0.355	3.890	10.96
2	0.818	5.322	6.51
3	1.366	6.681	4.89
4	1.970	7.994	4.06
5	2.613	9.274	3.55
6	3.286	10.532	3.21

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