THE OPEN UNIVERSITY OF SRI LANKA

FACULTY OF ENGINEERING TECHNOLOGY

POSTGRADUATE DIPLOMA IN INDUSTRIAL ENGINEERING – LEVEL 7

FINAL EXAMINATION – 2005/2006

MEX 7214/MEP1204 – QUALITY AND RELIABILITY ENGINEERING

DATE : ***03 rd April 2007***

TIME : ***0930 hrs – 1230 hrs***

DURATION: ***Three (03) hours***

Answer any five (05) questions. All questions carry equal marks. Normal Distribution Table and exponential Distribution Tables are provided.

1. (a) Quality of Design and Quality of Conformance are two basic parameters essential for meeting customer requirements. Explain the two parameters using suitable examples.

   (b) Quality Planning, Quality Control and Quality Improvement are three important phases in developing a successful quality programme. They are often referred to as Quality Trilogy. Explain the features of each of those phases.

2. (a) Define "Reliability" and explain the important terms associated with the definition.

   (b) What is meant by "Failure Mode and Effect Analysis (FMEA)" Briefly explain the steps of carrying out this type of analysis.

   (c) A Washing machine requires 45 minutes to clean a load of clothes. The meantime between failure of the machine is 75 hours. Assuming a constant failure rate, what is the chance of the machine completing a washing cycle without failure ?

3. (a) "Process Approach" is a concept widely used in quality management systems. Explain the concept briefly and write an account of the important elements of this approach.

   (b) In order to implement the process approach, quality tools and practices have to be effectively applied. Write an account of some of the important quality tools and practices used for this purpose.

4. (a) Meeting requirements of external customers is a vital factor for the survival of an organization. In order to achieve this goal it is important to satisfy numerous internal customers found in various processes in an organization. Explain the concept of internal customer.

(b) What is meant by Quality Costs ?

You are assigned the task of preparing a plan to launch a quality cost project in a company. Outline the activities that should be included in the plan in order to make the project beneficial to the company.

5. (a) Variation is a fact of industrial life. Product quality is always subject to variation. Explain the meaning of variation and the basic factors causing it. Using appropriate examples, explain the effect of variation on customers and manufacturers.

(b) A company producing rice bags has marked 5 kg as the net weight for each bag. The company wishes to keep 5 kg as the minimum net weight during the packing process. A study of the packing process was done and the mean net weight was found to e 5.05 kg with a standard deviation of 35 g. If the weight is normally distributed, find the answers to the following questions.

(i) Does the process produce bags less than 5 kg ?
If so what percentage ?

(ii) The company has set up an upper specification limit of 5.1 kg. Is the process capable of meeting this upper specification ?

(iii) If the company wishes to produce at least 97% of bags below the upper specification limit, what should be the mean of the process.

6. (a) Fraction defective control chart (p-chart) has to be setup at a particular stage of a process. Explain in a stepwise manner how you would proceed with this task.

(b) A fraction defective control chart has been set up at a particular stage of a process. In setting up the control chart, 100 items were inspected at each time. The average fraction defective line of this control chart is 0.032. The company has specified 6 percent as the maximum acceptable defective level. An inspector subsequently taking readings has recorded 4, 5, 2, 3, 7, 2, 8 defectives on consecutive samples of 100 items each. What is your opinion about the state of the process and the suitability of the control chart ?

7. (a) In the problem solving methodology it is important to narrow down a problem and then find root causes. Identify a quality tool for each of those purposes. Describe one of the tools briefly.

(b) A company manufacturing ball point pens has a production line where 8 employees are performing an assembling operation. The ball point pen consists of nose piece, refill and barrel. During the assembly operation refill is placed inside the barrel and the nose piece is fixed on to the barrel using adhesive. Some defectives are observed as unavoidable. In order to study the operation, defective ball point pens from each employee were collected over a period of time. A ball point pen is defective due to 5 types of defects. The data collected is shown in the table below. The numbers represent defectives by employee categorized under each defect type. Analyse the set of data using an appropriate quality tool and present your conclusions.

Table – Defective ball point pens.

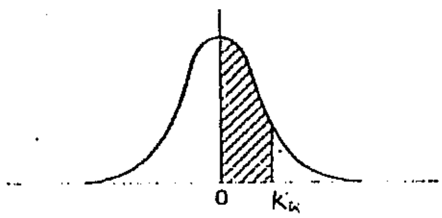
Employee	Defect Type				
	1	2	3	4	5
A	15	53	50	12	4
B	28	10	48	8	8
C	5	65	59	4	22
D	30	59	163	132	75
E	32	20	81	28	18
F	18	20	46	12	11
G	32	16	106	48	62
H	8	25	39	10	18

8 (a) Histogram analysis has been done on a bottle filling process in order to understand the state of the process. Analysis shows that the process follows normal distribution with mean 104 g and standard deviation 0.8 g. Filling specification has been decided as 100 g minimum and 105 g maximum. Comment on the state of the process. What action would you suggest for continuation of the process.

(b) Analysis done on a second filling line shows that the process is normally distributed with mean 103 g and standard deviation 1.4 g. Comment on the state of this process. What actions would you suggest for improvement. Filling specification is the same as (a).

Table A Normal Distribution Areas*

Fractional parts of the total area (1.000) under the normal curve between the mean and a perpendicular erected at various numbers of standard deviations (K) from the mean. To illustrate the use of the table, 39.065 percent of the total area under the curve will lie between the mean and a perpendicular erected at a distance of 1.23σ from the mean.



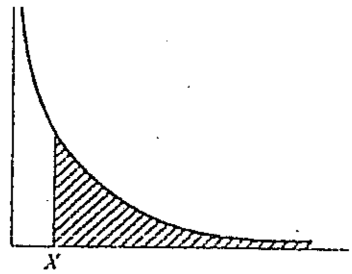
Each figure in the body of the table is preceded by a decimal point.

K	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	00000	00399	00798	01197	01595	01994	02392	02790	03188	03586
0.1	03983	04380	04776	05172	05567	05962	06356	06749	07142	07535
0.2	07926	08317	08706	09095	09483	09871	10257	10642	11026	11409
0.3	11791	12172	12552	12930	13307	13683	14058	14431	14803	15173
0.4	15554	15910	16276	16640	17003	17364	17724	18082	18439	18793
0.5	19146	19497	19847	20194	20540	20884	21226	21566	21904	22240
0.6	22575	22907	23237	23565	23891	24215	24537	24857	25175	25490
0.7	25804	26115	26424	26730	27035	27337	27637	27935	28230	28524
0.8	28814	29103	29389	29673	29955	30234	30511	30785	31057	31327
0.9	31594	31859	32121	32381	32639	32894	33147	33398	33646	33891
1.0	34134	34375	34614	34850	35083	35313	35543	35769	35993	36214
1.1	36433	36650	36864	37076	37286	37493	37698	37900	38100	38298
1.2	38493	38686	38877	39065	39251	39435	39617	39796	39973	40147
1.3	40320	40490	40658	40824	40988	41149	41308	41466	41621	41774
1.4	41924	42073	42220	42364	42507	42647	42786	42922	43056	43189
1.5	43319	43448	43574	43699	43822	43943	44062	44179	44295	44408
1.6	44520	44630	44738	44845	44950	45053	45154	45254	45352	45449
1.7	45543	45637	45728	45818	45907	45994	46080	46164	46246	46327
1.8	46407	46485	46562	46638	46712	46784	46856	46926	46995	47062
1.9	47128	47193	47257	47320	47381	47441	47500	47558	47615	47670
2.0	47725	47778	47831	47882	47932	47982	48030	48077	48124	48169
2.1	48214	48257	48300	48341	48382	48422	48461	48500	48537	48574
2.2	48610	48645	48679	48713	48745	48778	48809	48840	48870	48899
2.3	48928	48956	48983	49010	49036	49061	49086	49111	49134	49158
2.4	49180	49202	49224	49245	49266	49286	49305	49324	49343	49361
2.5	49379	49396	49413	49430	49446	49461	49477	49492	49506	49520
2.6	49534	49547	49560	49573	49585	49598	49609	49621	49632	49643
2.7	49653	49664	49674	49683	49693	49702	49711	49720	49728	49736
2.8	49744	49752	49760	49767	49774	49781	49788	49795	49801	49807
2.9	49813	49819	49825	49831	49836	49841	49846	49851	49856	49861
3.0	49865	49869	49874	49878	49882	49886	49889	49893	49896	49900
3.1	49903	49906	49910	49913	49915	49918	49921	49924	49926	49929
3.2	49931	49934	49936	49938	49940	49942	49944	49946	49948	49950
3.3	49952	49953	49955	49957	49958	49960	49961	49962	49964	49965

* This table has been adapted, by permission, from F. C. Kent, *Elements of Statistics*, McGraw-Hill Book Company, New York, 1924.

Table B Exponential distribution values of $e^{-X/\mu}$ for various values*

Fractional parts of the total area (1.000) under the exponential curve greater than X. To illustrate: if X/μ is 0.45, the probability of occurrence for a value greater than X is 0.6376.



X/μ	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	1.000	0.9900	0.9802	0.9704	0.9608	0.9512	0.9418	0.9324	0.9231	0.9139
0.1	0.9048	0.8958	0.8869	0.8781	0.8694	0.8607	0.8521	0.8437	0.8353	0.8270
0.2	0.8187	0.8106	0.8025	0.7945	0.7866	0.7788	0.7711	0.7634	0.7558	0.7483
0.3	0.7408	0.7334	0.7261	0.7189	0.7118	0.7047	0.6977	0.6907	0.6839	0.6771
0.4	0.6703	0.6637	0.6570	0.6505	0.6440	0.6376	0.6313	0.6250	0.6188	0.6126
0.5	0.6065	0.6005	0.5945	0.5886	0.5827	0.5769	0.5712	0.5655	0.5599	0.5543
0.6	0.5488	0.5434	0.5379	0.5326	0.5273	0.5220	0.5169	0.5117	0.5066	0.5016
0.7	0.4966	0.4916	0.4868	0.4819	0.4771	0.4724	0.4677	0.4630	0.4584	0.4538
0.8	0.4493	0.4449	0.4404	0.4360	0.4317	0.4274	0.4232	0.4190	0.4148	0.4107
0.9	0.4066	0.4025	0.3985	0.3946	0.3906	0.3867	0.3829	0.3791	0.3753	0.3716

X/μ	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1.0	0.3679	0.3329	0.3012	0.2725	0.2466	0.2231	0.2019	0.1827	0.1653	0.1496
2.0	0.1353	0.1225	0.1108	0.1003	0.0907	0.0821	0.0743	0.0672	0.0608	0.0550
3.0	0.0498	0.0450	0.0408	0.0369	0.0334	0.0302	0.0273	0.0247	0.0224	0.0202
4.0	0.0183	0.0166	0.0150	0.0136	0.0123	0.0111	0.0101	0.0091	0.0082	0.0074
5.0	0.0067	0.0061	0.0055	0.0050	0.0045	0.0041	0.0037	0.0033	0.0030	0.0027
6.0	0.0025	0.0022	0.0020	0.0018	0.0017	0.0015	0.0014	0.0012	0.0011	0.0010

*Adapted from S. M. Selby (ed.), *CRC Standard Mathematical Tables*, 17th ed., CRC Press, Cleveland, Ohio, 1969, pp. 201–207.