Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – WINTER • 2013

Subject code: 1720908 **Date: 23-06-2014**

Subject Name: Reliability Engineering

Time: 10.30 am – 01.00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** What are the key reasons for using reliability engineering? Explain Reliability bath tub curve with neat diagram. **07**

(b) What do you mean by Quality Function Development (Q.F.D.)? Also Elaborate the procedure of making QFD. **07**

Q.2 **(a)** What is Design of Experiments (D.O.E.)? What are the components and benefits of D.O.E.? **07**

(b) Explain Fault Tree Analysis with suitable example; also mention the fundamental difference between Fault Tree Diagrams (FTDs) and Reliabity Block Diagrams (RBDs). **07**

OR

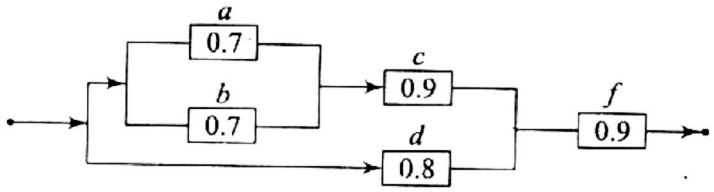
(b) For an emergency operation theater in a hospital, the power is obtained from the main city supply through a transformer connected in series. To ensure an uninterrupted supply, an auxiliary generator is also used with a suitable switch over. The probability of failure of city supply is 0.01 and the transformer reliability is 0.996. The auxiliary power generator has reliability factor of 0.99. Draw the block diagram for the system. Construct the fault tree and, based on this, calculate the reliability of the system. **07**

Q.3 **(a)** Write a short note on Failure mode effect analysis (FMEA) also explain FMECA. **07**

(b) Explain two-state Markov process. (Single component with repair) and derive the equations for steady state probabilities. **07**

OR

Q.3 **(a)** Five elements (a, b, c, d and f) of a system are connected as shown in fig, which also indicates the reliability of each element. Calculate the system reliability **07**



(b) A pump motor exhibiting a constant hazard rate has a reliability of 90 percent from operating time of 1000 hours. **07**

(a) What is the average failure rate of the pump motor?
(b) What is the MTBF?
(c) What is the reliability of the item for an operating time of 2000 hours? And for 4000 hrs?
(d) Corresponding to a reliability of 0.5, what is the operating time?

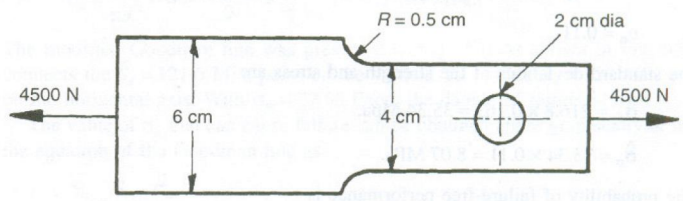
Q.4 **(a)** Explain in brief Accelerated test method for reliability. **07**

(b) Explain the load-strength interference in Reliability. **07**

OR

Q.4 **(a)** The flat bar shown in fig is subjected to an axial load of 4500 N which is completely reversed. The mean tensile strength of the material is 550 MPa. Estimate the reliability assuming that both stress and strength are normally distributed. The flat is 6 mm thick. **07**

For machined surface d = 4.51, e = -0.265, and V_{ka} = 0.06, K_b = 1, K_a = 0.923, V_{kc} = 0.044, Stress concentration factor Ŭ= 2.18 and notch sensitivity factor q = 0.81.



(b) Estimate the probability of failure free performance by the wear criterion of a sliding contact working in dry friction and with the following data, **07**

H_1 for bearing ranges from $40H_B$ to $50H_B$,

H_2 for shaft ranges from $350H_B$ to $370H_B$,

Shaft dia = 30 mm, specification, H8/d8 fit,

Average pressure ʎ = 5Mpa,

Coefficient of variation for pressure V_p = 0.035,

Velocity of traverse g = 0.2m/sec,

Range for coefficient of friction f is 0.05 to 0.10,

Assume mean wear intensity ' = 10^{-10},

Minimum allowable play h_{max} = 0.15 mm,

Service time of assembly = 800 hr, for 30H8/d8 fit h_{in} = 0.073, and the mean square deviations for bore and shaft diameters are respectively 0.0055 mm and 0.0055 mm.

Q.5 **(a)** Explain Pareto analysis using appropriate example also discuss its usefulness in reliability engineering. **07**

(b) Write short note on reliability growth monitoring of repairable systems. **07**

OR

Q.5 **(a)** The life (in hours) of electric bulb is distributed normally with mean μ and standard deviation ů. The life of 83.40% the bulb is less than 1400 hours and that of 2.5% of the bulb is more than 1800 hours. Determine the values of μ and ů. **07**

(b) A privately managed operating theatre has its own diesel power generating unit. From past experience, it is observed that the average length of trouble free service of the generating unit is 20 days. After a breakdown, it takes on an average one day to restore the unit to an operating condition. Assume that the time between breakdowns and the repair time are both exponentially distributed. If the generating unit is in an operating condition now, determine **07**

(a) The probability that it will breakdown within the next 30 days,

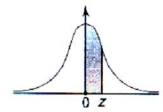
(b) The probability that it will breakdown on the seventh day from now,

(c) The proportion of time it will be in the operating condition over a long period of time,

(d) The average availability over a long period of time.

Appendix B Areas under the Standard Normal Curve from 0 to z

To get $\Phi(z)$. If z is positive, add 0.5 to the values given in this table. If z is negative in $\Phi(z)$, subtract the value given from 0.5.



z	0	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0754
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2258	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2518	0.2549
0.7	0.2580	0.2612	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2996	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389

z	0	.01	.02	.03	.04	.05	.06	.07	.08	.09
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

z	0	.01	.02	.03	.04	.05	.06	.07	.08	.09
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000

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