Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.TECH (ME)/SEM-2/MMT-205A/2011

2011
RELIABILITY

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Answer any *five* questions. 5 × 14 = 70

1. A manufacturer of light bulbs is interested in estimating the mean life of bulbs. 200 bulbs are subjected to testing. The bulbs are observed and the failures in 1000 time intervals are recorded as follows :

Time Intervals (hour)	Failures (Nos.)
0 – 1000	100
1001 – 2000	40
2001 – 3000	20
3001 – 4000	15
4001 – 5000	10
5001 – 6000	8
6001 – 7000	7

Evaluate hazard rate. failure density function and reliability and plot these functions against time.

2. A manufacturer of light bulbs is interested in estimating the mean life of bulds. 200 bulbs are subjected to testing. The bulbs are observed and the failures in 1000 time intervals are recorded as follows :

Time interval (h)	Failures
0-1000	100
1001-2000	40
2001-3000	20
3001-4000	15
4001-5000	10
5001-6000	8
6001-7000	7

Plot the failure density function, hazard rate function and the reliability from the data.

3. In a nuclear plant, the times to failure (in hours) of the feed-water pumps are recorded. Use the total-time-on test plot to evaluate the failure data.

i	$t_i \times 10^4$	$(n-i+1)(t_i-t_{i-1}) \times 10^4$	$H(t_i) \times 10^4$	$H(t_i)$
1	0.14	1.40	1.40	0.14
2	0.35	1.89	3.29	0.33
3	0.59	1.92	5.21	0.53
4	0.76	1.19	6.40	0.65
5	0.86	0.60	7.00	0.71
6	0.90	0.20	7.20	0.73
7	1.16	1.04	8.24	0.83
8	1.20	0.12	8.36	0.84
9	1.91	1.42	9.78	0.99
10	2.04	0.13	9.91	1.00

4. What is meant by 'reliability' ? Deduce an expression of reliability from the basic definition of hazard rate.

5. What is meant by 'redundancy' and why is it so important in the satisfactory working of a system ? Classify various types of redundancy and explain the significant difference in working of each type.

6. Discuss in detail fault tree analysis and its qualitative and quantitative evaluation. Outline the symbology of fault trees and explain them in detail.

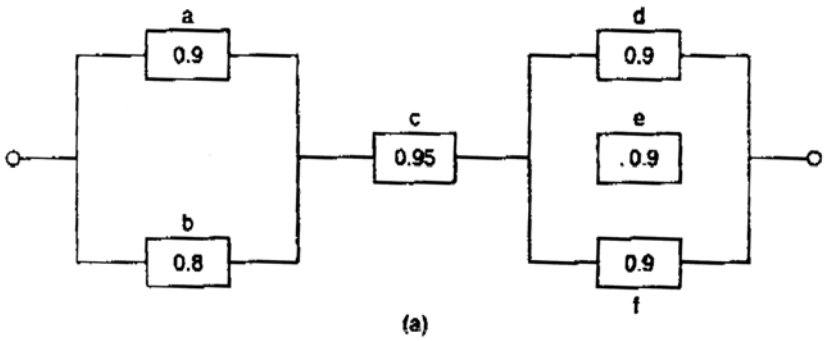
7. a) Explain the concept of burn-in test.

   b) Determine the burn-in test time for a new product. The product after reliability growth testing, has a Weibull failure distribution with $\beta = 0.3$ and 0 – 3,750,000 hour. Contract specifications require 0.95 reliability at 1000 operating hours.

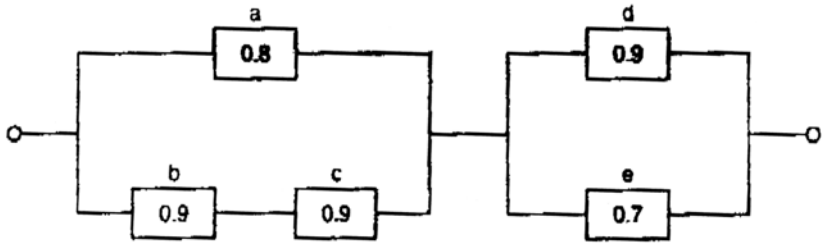
8. What is sequential testing ?

   Develop a sequential test for the CFR model to test the null hypothesis that the MTTF = 100 hour versus the alternate hypothesis that the MTTF = 50 hours. Set $\alpha = 0.1$ and $\beta = 0.5$. What is the minimum number of failures necessary to reject the null hypotheses, and what is the minimum time on test before the null hypothesis may be accepted ?

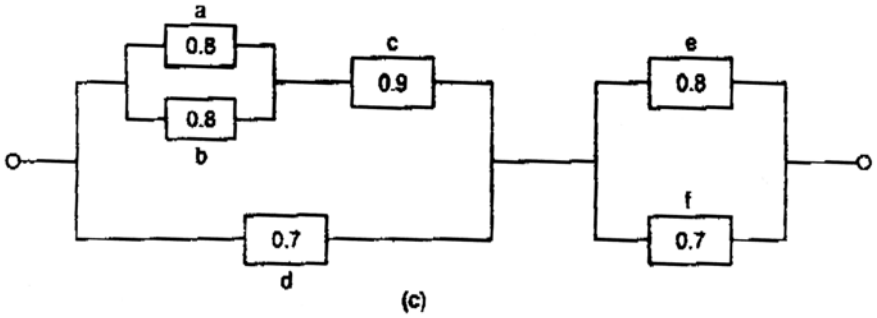
9. Calculate the reliabilities of the systems shown in the Figures – (a), (b) and (c) :



(a)



(b)



(c)