



KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SET 500: SYSTEM RELIABILITY AND PLANT MAINTENANCE

DATE: Monday 28th November, 2011

TIME: 2.00 p.m. – 4.00 p.m.

Instructions

- The paper has got **five** questions with equal marks
- Answer **any three** questions

Question one

- Identify four key elements of reliability engineering (4 marks)
- Discuss the following system reliability terms
 - Probability Density Function and Cumulative Distribution Function (5 marks)
 - Mean Time Between Failures and Failure Rate (5 marks)
- Suppose it is desired to estimate the failure rate of a certain component. A test can be performed to estimate its failure rate. Ten identical components are each tested until they either fail or reach 1000 hours, at which time the test is terminated for that component. Explore the failure rate under the available conditions. (6 marks)

Question two

- What is a bath tub curve? (4 marks)
- What is the importance of reliability tests in various stages of product development? (6 marks)
- With suitable illustration derive the following expression (10 marks)

$$h(t) = \frac{f(t)}{R(t)} = \lambda$$

Where: $h(t)$ = hazard rate
 $f(t)$ = failure density function
 $R(t)$ = reliability function
 λ = an element of a probability distribution

Question three

- Sketch a transition diagram of repairable component (2 marks)
- Differentiate between the following terms
 - Maintainability and Availability (3 marks)
 - Preventive maintenance and Corrective maintenance (3 marks)
 - Inherent availability and Achieved availability (3 marks)
- An automobile machine is repaired after operating some distance in Kilometers. Table Q₃ gives its failure data. Use it to determine and plot the following:
 - Distribution function, F(t) (3 marks)
 - Reliability function R(t) (3 marks)
 - Probability density, f(t) (3 marks)

Table Q₃: Failure data

i	t_i (Km)	$t_{i+1} - t_i$ (Km)
0	0	43,500
1	43,500	8,500
2	52,000	11,500
3	63,500	8,500
4	72,000	12,500
5	84,500	9,000
6	93,500	7,500
7	101,000	10,500
8	111,500	4,500
9	116,000	7,500
10	123,500	-

Question four

- Outline the approaches of various forms of maintenance (6 marks)
- Discuss evolution of plant maintenance (6 marks)
- Derive an expression of a steady state availability of a system and give its significance (8 marks)

Question five

- Outline differences between the following terms
 - Series system and parallel system (2 marks)
 - Passive redundancy and active redundancy (2 marks)
- Sketch a stand-by system with n units. What are the key assumptions of the system? What is the expression of failure time of the system? (6 marks)
- A system is to be designed with an overall reliability of 0.999 using components having individual reliabilities of 0.7. Determine
 - the minimum number of components that must be connected in parallel? (3marks)
 - If the system is re-orientated to appear as in figure Q₅, derive its expression (3 marks)
 - the unreliability of the system Q₅ if all components have a reliability of 0.8 (4marks)

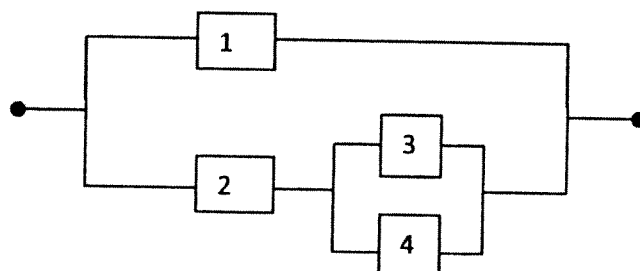


Figure Q₅