TECHNICAL UNIVERSITY OF MOMBASA

Paper 1

EXAMINATION RUBRIC

FACULTY ENGINEERING AND TECHNOLOGY

DEPARTMENT ELECTRICAL & ELECTRONIC

Common ☐ **Not common** ☐

COURSE/CLASS **Bachelor of Science in Electrical and Electronic Engineering**

UNIT CODE **EEE 2503**

PAPER **Reliability Engineering**

SERIES **May 2016**

NO. OF STUDENTS ☐

INSTRUCTION TO CANDIDATES

Answer Question One (Compulsory) and any other Two Questions

Name of setter: Stephen Sande

Name of moderator: Prof. Heywood Ouma

Date submitted to examination centre _____

TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR :

THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2503 RELIABILITY ENGINEERING

END OF SEMESTER EXAMINATION

SERIES: MAY 2016 **TIME : 2 HOURS**

DATE:

Instructions to Candidates

You should have the following for this examination:

- *Answer Booklet, examination pass and student ID*

This paper consists of five questions;

Question ONE is compulsory. In addition attempt any other TWO questions

Do not write on the question paper

Question ONE (Compulsory 30 marks)

(a) Explain using relevant examples how the following factors underline the importance of reliability engineering in designed systems:

(i) Circuit complexity (ii) Public pressures (iii) Quality related lawsuits

(9 marks)

(b) Highlight the need for the following maintainability design goals:

(i) Standardization (ii) Modular design

(6 marks)

(c) Explain how engineering systems reliability data contributes in the development of organizational policies in the following areas:

(i) Costs due to maintenance (ii) Estimation of equipment availability

(iii) Determination of labour hours and other related resources to perform maintenance .

(9 marks)

(d) An instrumentation circuit on-board a vehicle ($K_E = 10$) uses five transistors, 8 capacitors and 10 resistors. The failure rates for each of the components are: $0.08 \times 10^{-6}/hr$ for transistors; $0.1 \times 10^{-5}/hr$ for capacitors and $0.03 \times 10^{-6}/hr$ for resistors. Determine the MTBF and the overall failure (Faults$/10^6 hrs$ / of the circuit. (6 marks)

Question TWO

(a) Explain how engineering systems reliability data aids in the development of organizational policies in the following areas:

(i) Inspection and maintenance (ii) Warranty

(4 marks)

(b) (i) By making appropriate assumptions show that

$$R(t) = e^{-\lambda t}$$

(ii) A system design requires 10 identical components in parallel. If the overall reliability

must not be less than 0.98, determine the minimum reliability of each component.

(10 marks)

(c) A large generator system designed for continuous operation fails 10 times in a period of 3 years. If the total time for repairs during this period is 45 days, determine:

(i) Mean-time-to-repair (MTTR in days) (ii) Mean-time-between-failure (MTBF in days)

(iii) Unavailability of the plant due to breakdown

(6 marks)

Question THREE

(a) Highlight the basic factors considered in determining failure rate prediction under reference conditions (parts count) stating any assumptions made..

(4 marks)

(b) Define the following:

(i) Reliability analysis (ii) Fault tree analysis

(2 marks)

(c) Highlight FOUR factors that have to be considered in order to achieve good maintainability

(8 marks)

(d) The probability of each engine of a three-engine aircraft completing a flight without failure is 0.99. The probability of completing the flight with one engine operative is 0.45. If more than one engine is inoperative the flight is cancelled. Determine the probability of the aircraft reaching its destination.

(6 marks)

Question FOUR

(a)

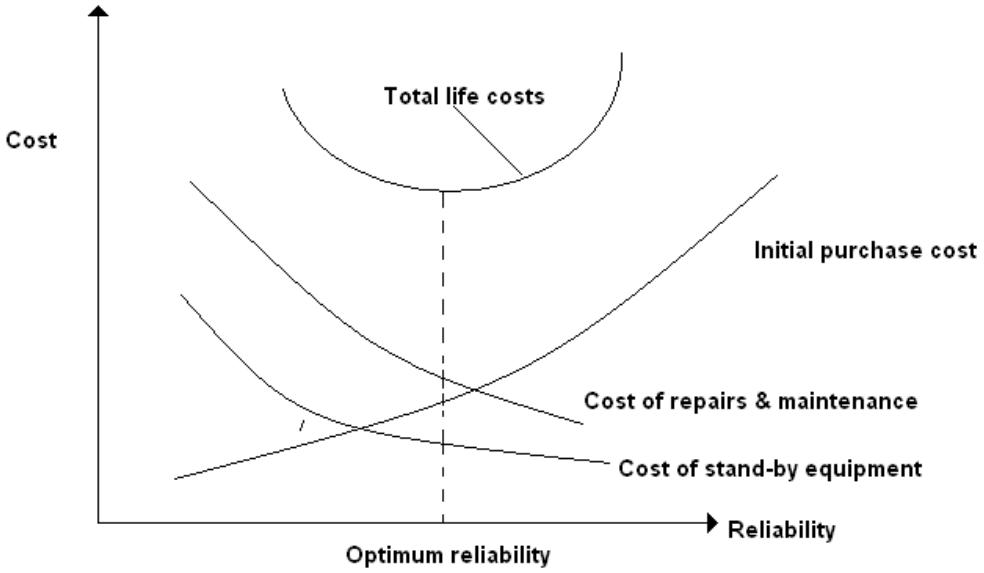

Fig. Qu.4(a)

Fig. Qu.4(a) shows the general way in which costs vary with reliability. From the users' viewpoint, the most rational criterion for deciding which design is best is that of minimum total life cost. Discuss.

(5 marks)

(b) (i) With the aid of the bath tub curve describe the three phases of the reliability life cycle of an equipment.

(ii) For each of the three phases in b(i) explain at least ONE way in which the failure rate can be reduced or minimized.

(7 marks)

(c) A power generation system consists of three generators A, B and C connected in parallel. Reliability for one day's operation is 0.99 for A, 0.97 for B and 0.98 for C. The probability of supplying the daily power needs is 99% if all the three generators are operational, 67% if one generator fails and 33% if two generators fail. Determine the probability of success in supplying the daily power requirements. (8 marks)

Question FIVE

(a) Explain THREE reasons why records are important in maintenance work.
(6 marks)

(b) The probability of a power failure in a period of one year at a particular location is 6%. Determine the probability of experiencing:

(i) No failure (ii) At least one failure during a five year period
(2 marks)

(c) Records of the lives of incandescent lamps show the following results: 943, 886, 1075,

901, 1113, 1094, 873, 917, 1151, 892, 1121, 1186 hours; and hence calculate:

(i) The mean and standard deviation of the sample

(ii) How many in this sample are likely to have lives less than 898 hrs if this sample is

representative of a batch of 3000 lamps.
(8 marks)

(d) Describe the failure mode mechanisms associated with the following environmental conditions:

(i) Temperature (ii) Vibration
(4 marks)