TECHNICAL UNIVERSITY OF MOMBASA

Paper 2

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) High acquisition cost. (iii) Safety (iii) Global competition (9 marks)

(b) Assume that an engineering system is composed of four independent and identical units in parallel. At least three units must operate normally for system success. Determine:

(i) System reliability (ii) System mean-time-to-failure if the unit failure rate is 0.0035 failures per hour. (6 marks)

(c) Describe using relevant examples the factors that come into play when designing for reliability considering

(i) Component selection (ii) Mechanical design (iii) Component redundancy (9 marks)

(d) An electronic equipment on-board an aircraft ($K_E = 20$) contains the following components:

ITEM	QUANTITY	FAILURE RATE (%/1000 HRS)
Capacitors	20	0.03
Inductors	2	0.005
Transistors	10	0.01
Resistors	40	0.004
Diodes	5	0.04
Soldered connections	100	0.001
Wrapped connections	200	0.0001

(i) Calculate for this equipment the reliability for an operating period of 5000 hrs.

(ii) Determine the suitability of d (i) if an MTBF greater than 150,000 hrs is required.

(iii) If not suitable suggest changes in improving the reliability in d(i) to fit the required MTBF. (6 marks)

Question TWO

(a) Describe using relevant examples the factors that come into play when designing for reliability considering:

(i) The effect of tolerances (ii) Protection against interference and noise

(iii) Derating (6 marks)

(b) A large generator system designed for continuous operation fails 5 times in a period of 2 years. If the total time for repairs during this period is 25 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)

(c) A machine has 30 resistors and 21 capacitors. The failure rate of resistors and capacitors are 0.06 and 0.26 respectively. The time in location, isolation, removal, replacement and adjustment are respectively shown in Table Qu. 2(d). Calculate the:

(i) Mean-time of maintenance action T_m (ii) Maintenance action rate μ

(iii) Maintainability in 1 hr and 2 hrs respectively (8 marks)

	Location	Isolation	Removal	Replacement	Adjustment
Resistor	**0.03**	**0.015**	**0.07**	**0.05**	**0**
Capacitor	**0.16**	**0.2**	**0.01**	**0.04**	**0**

Table Qu. 2(d)

Question THREE

(a) Highlight the basic factors considered in determining failure rate prediction under operating conditions (parts stress). (4 marks)

(b) Describe the key elements of the following reliability centred maintenance program:

(i) Reactive (ii) Predictive testing and inspection (6 marks)

(c) A communication system comprises of units A, B, C, D, E and is normally unattended apart from monthly maintenance visits. The failure rates for each unit are as follows:

UNIT	A	B	C	D	E
FAULT/1000 HRS	**0.003**	**0.0015**	**0.08**	**0.065**	**0.0045**

Units C and D are duplicated with automatic switching so that the system is operative if either of the twin units is working. Determine:

(i) Reliability of the system

(ii) How many visits to repair are likely during a six year period. (10 marks)

Question FOUR

(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 costs. Discuss. (5 marks)

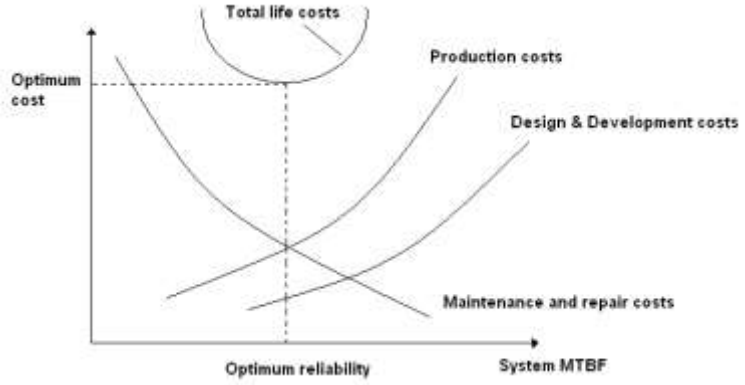

Fig. Qu. 4(a)

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

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

(ii) $MTBF(MTTF) = \frac{1}{\lambda}$ (11 marks)

(c) Three sets of airborne communication equipment were tested in an environmental chamber and failed after 640, 750, and 980 hrs respectively. Determine the demonstrated MTBF at 90% confidence level if they are assumed to have a constant failure rate. (4 marks)

Question FIVE

(a) Explain FOUR benefits of written instructions in maintenance (4marks)

(b) (i) Describe the concept of worst-case design

(ii) Explain any two disadvantages of worst-case design. (4 marks)

(c) A laboratory buys 80 oscilloscopes from supplier A, 35 from B and 25 from C. The probability of any one being faulty is 0.05 for A, 0.10 for B and 0.15 for C. Determine the probability that any one selected at random from 160 will work correctly. (4 marks)

(d) (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. (8 marks)