ELIZADE UNIVERSITY ILARA MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

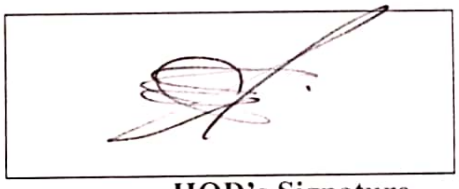
2020/2021 FIRST SEMESTER EXAMINATION

COURSE TITLE: RELIABILITY AND MAINTAINABILITY OF ELECTRICAL AND ELECTRONIC SYSTEMS

COURSE CODE: EEE 511

EXAMINATION DATE:

COURSE LECTURER: DR K. O. TEMIKOTAN



HOD's Signature

TIME ALLOWED: 2 HOURS

INSTRUCTIONS

1. ANSWER ANY FOUR QUESTIONS.
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, AND POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM.
3. YOU ARE NOT ALLOWED TO BORROW ANY WRITING MATERIALS AND CALCULATORS DURING THE EXAMINATION.
4. SMART WATCHES OR SIMILAR DEVICES ARE NOT ALLOWED IN THE EXAMINATION VENUE.

QUESTION ONE

a) Write a mathematical expression for Arrhenius' Law and describe each of the parameters involved. 3 marks

b) State the expression for (i) constant voltage and (ii) constant temperature 2 marks

c) In a test to determine failure rate, the following conditions were recorded in Table Q 1;

Table Q 1: Failure Rates for Three Conditions

S/N	CONDITION	RESULT (λ)
1	Failure rate for V and T	0.025
2	Failure rate for V and 2T	0.100
3	Failure rate for 0.5 V and T	0.00125

If the rated temperature T is **30** °C, calculate the probable failure rate at one-third rated voltage V and two-third rated temperature T. 5 marks

QUESTION TWO

a) For the reliability block diagram shown in Figure Q 2, draw (i) an equivalent minimal-tie diagram and (ii) an equivalent minimal-cut diagram.

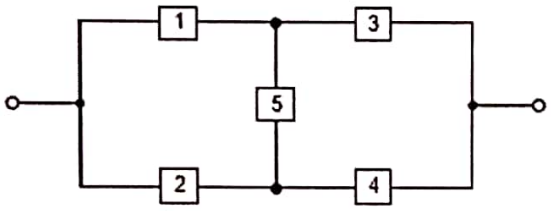


Figure Q 2

4 marks

b) For a redundant system with n independent identical components with constant failure rate λ, show that the MTTF is equal to

$$\frac{1}{\lambda}\sum_{i=1}^{n} nC_i \frac{(-1)^{i-1}}{i}$$ 6 marks

c) If $\boldsymbol{\lambda = 0.02}$ per hour, what is the minimum value of n such that MTTF is at least 350 hours? 5 marks

QUESTION THREE

a) Explain briefly what quality of service means for a communication system. 3 marks

b) Define each of the following metrics for measuring quality of service (QoS);

i. Call Completion Rate

ii. Answer Seizure Ratio

iii. Dropped Call Rate 3 marks

c) List and define four parameters which communication systems can use to measure QoS quantitatively. 4 marks

d) 100 routers are tested for 1000 hours and 4 failures occur during this time. Estimate (i) the failure rate and (ii) the mean time to failure of the routers. 5 marks.

QUESTION FOUR

a) State four necessary conditions that must be met while selecting component parts in order for you to design a reliable system. 5 marks

b) The reputable Sholaps and Shalews Engineering Services Limited delivered the following items to your company, 20 pcs. 500 kVA, 11000/400 V distribution transformers, 30,000 pcs of various insulators, 20 drums of 100 mm^2 all aluminium conductor each 3000m long, 400,000 pcs of bolts and nuts, 2 drums of 35 mm^2 copper conductor each 1000 m long, 500 earth rods and 300 anchor assembly. The materials are meant for the electrification of Golden Gates Estates, Ilara Mokin. Explain what precautions and processes you will deploy before, during and after the completion of the project to ensure reliability of the installation. 10 marks

QUESTION FIVE

a) List five causes of early failures in hardware. 2 marks

b) An electronic circuit consists of 5 silicon transistors, 6 silicon diodes, 7 resistors, and 8 ceramic capacitors connected in series configuration. The hourly failure rate of each component is given below.

Silicon transistor $\lambda_t = 2 \times 10^{-5}$

Silicon diode $\lambda_d = 3 \times 10^{-5}$

Composition resistor $\lambda_r = 4 \times 10^{-5}$

Ceramic capacitor $\lambda_c = 5 \times 10^{-5}$

Calculate the reliability of the circuit for 10 hours, when the components follow exponential distribution. 6 marks

c) According to the Jelinski-Moranda reliability growth model, the program failure rate at the ith failure interval is given by,

$$\lambda(t_i) = \phi[N - (i-1)], i = 1, 2, \ldots, N.$$

i. Find the probability density function $f(t_i)$ of the model 2 marks

ii. Determine the reliability $R(t_i)$ of the model 3 marks

iii. State the mean time to failure (MTTF)) at time t. 2 marks

QUESTION SIX

i. If a device has a failure rate of $\lambda(t) = (0.015 + 0.02t)$, where t is in years, calculate the reliability for a 5 - year design life, assuming that no maintenance is performed. 5 marks

ii. A communication system comprises four component modules, A, B, C, and D connected in series. Given their MTBF and MTTR as contained in Table Q 6;

Table Q 6

UNIT	MTBF (Hours)	MTTR (Hours)
A	250	5
B	200	10
C	650	6
D	800	8

i) Calculate the availability of the system. 5 marks

ii) Calculate the availability of the system if two of the unit C modules are connected in parallel. 5 marks