Ref. No.: Ex/PG/ME/T/115A/2024

M.E. MECHANICAL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM 2024

Sub: RELIABILITY ENGG. **Time: Three hours** **Full Marks: 100**

(*Answers of questions of* PART-I *and* PART-II *must be written in separate answer scripts*)

PART-I

Marks: 50

(*Answer question 1 and any two from the rest*)

(*Tables of statistical distributions may be used if required*)

1a) The failure distribution of a component follows normal distribution with values of parameters given below:

Mean time to failure = 2500 hour Standard deviation of time to failure = 275 hour

Determine the followings:

(i) Reliability and failure rate for a specified time period of 2150 hours. (8)

(ii) Specified time period for target reliability of 95%. (4)

1b) The nonlinear failure rate function of a component is given by $\lambda(t) = \alpha . t^{\beta}$, where α and β are constants and t is the time to failure. Determine the expression for mean time to failure (MTTF). (6)

2) Explain the three parameter Weibull failure law with explanation of its parameters. Derive the expressions of $F(t)$, $R(t)$ and $f(t)$ for exponential failure law from the assumption that failure rate is constant. Also draw $F(t)$ vs t and $f(t)$ vs t graph for exponential failure law.

(8+6+2)

3) Explain the analytical method used for failure parameter estimation.

The reliability testing laboratory provides the following data regarding time to failure (in hour) for 10 similar components as given below:

1850, 10620, 5450, 8210, 6320, 7850, 7010, 2820, 8640, 3950

Assuming two-parameter Weibull distribution and using analytical method, estimate the values of failure parameters. What will be the reliability and failure rate for a specified time period of 3300 hours? (10+6)

[Turn over

failure parameters. What will be the reliability and failure rate for a specified time period of 3300 hours? (10+6)

4) Write short notes on the followings (any four): (4 × 4)

a) Graphical method for failure parameter estimation

b) Median rank

c) Bath tub curve

d) Types of failure test data

e) Types of hazard models

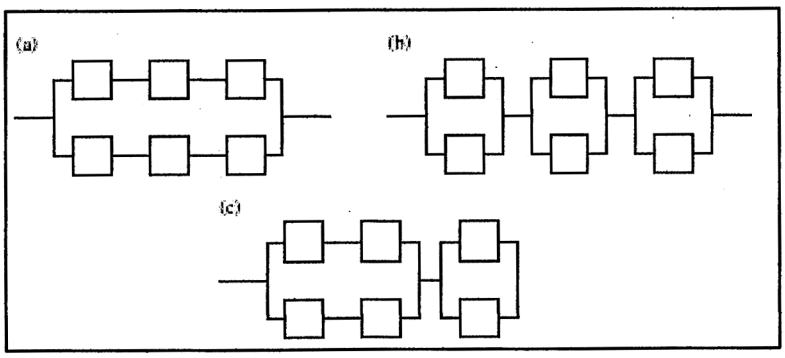
f) Fitting of failure data into exponential law

PART-II

Marks: 50

(Answer ***any five*** questions. All questions carry equal marks)

(a) Given six identical units each having a reliability of 0.85, determine the reliability of three systems, resulting from the arrangements of units as shown below: (10)



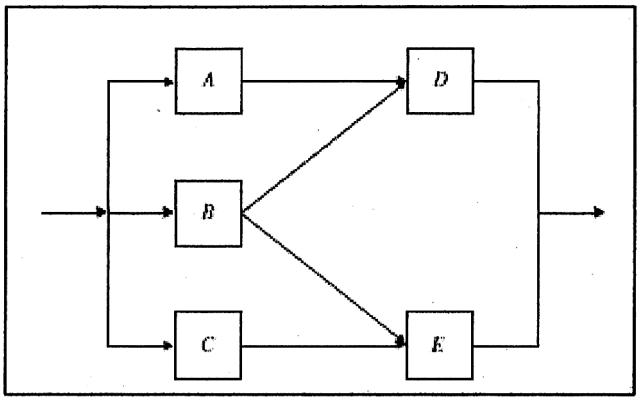
(b) Repeaters are devices that amplify signals and send them to other network segments. They play a vital role in building large networks. A repeater amplifies signals such that they can reach two repeaters away

without loss or distortion. The repeaters are connected in series, and the signals are considered lost when two consecutive repeaters fail. (10)

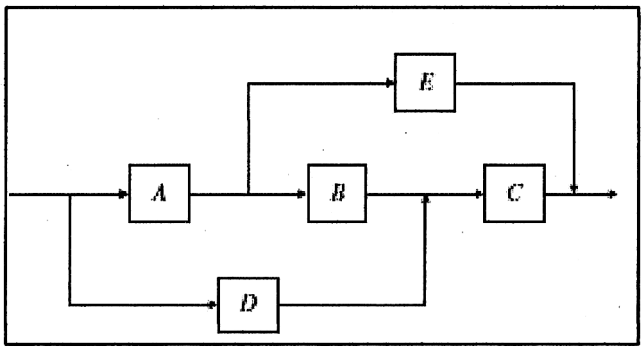
Assume that five repeaters are connected in series and the probabilities of failure of repeaters 1 through5 are $q1$=0.62, $q2$=0.079, $q3$=0.25, $q4$=0.22, $q5$=0.42. Determine the reliability of the system.

(c) Derive the reliability of k-out-of-m:G system. (10)

(d) Find the reliability of the following network, using A as the keystone component. (10)



(e) Consider the system shown below. Use the tie-set and cut-set methods to estimate the system reliability. (10)



(f) Derive reliability of n three-state components. (10)

(g) Explain probability of failure of a component under time-dependent stress and strength. Also discuss degradation pattern of strength of a unit over time. (10)