Department of Mathematics

Probability and Random Processes **15B11MA301**
Probability Theory and Random Processes **10B11MA411**
Tutorial Sheet 6 **B.Tech. Core**

Reliability

1. A microwave transmitter has exhibited a constant failure rate of 0.00034 failure per operating hour. Find MTTF, median of the distribution, reliability function, reliability over 30-days continuous operating period and design life for a reliability of 0.95 specification.

   Ans. 2941 hrs, 2039 hrs, $e^{-0.00034t}$, 0.78286, 150.86 hrs.

2. An appliance is advertised as having more than 10-year life. Its pdf is given by $f(t) = 0.1(1 + 0.05t)^{-3}; t \geq 0$. Find its reliability for the next 10 years if it has survived a 1-year warranty period. Find the MTTF. Ans. 0.4589, 20 years

3. Experience shows that the failure rate of a certain electrical component is a linear function. Suppose that after two full days of operation, the failure rate is 10% per hour and after three full days of operation, it is 15% per hour.
   (a) Find the probability that the component operates for at least 30 hours.

   (b) Suppose that the component has been operating for 30 hours. What is the probability that it fails within the next hour? Ans. (a) 0.3916 (b) 0.0616

4. Two components have the same MTTF; the first has a constant failure rate $\lambda = 0.141$ and the second follows a Weibull distribution with shape parameter equal to 2.
   (a) Find the characteristic life of the second component.
   (b) If for each component the design life reliability must be 0.8, how much longer (in percentage) is the design life of the second component than the first? Ans. (a) 8.003 (b) 138%

5. Specifications for a power unit consisting of 3 independent and serially connected components require a design life of 5 years with 0.95 reliability.
   (i) if the constant failure rates λ_1, λ_2 and λ_3 are such that $\frac{\lambda_1}{2} = \frac{\lambda_2}{1} = \frac{\lambda_3}{3}$, what should be the MTTF of each component of the system?
   (ii) If 2 identical power units are placed in parallel, what is the system reliability at 5 years and what is the system MTTF? Ans. (i) 292, 585, 195 (ii) 0.9975, 147 years

6. If three components each with constant failure rates 5, 10 and 15 per year are placed in parallel, what is the system reliability for 0.1 year and it's MTTF? Ans. 0.8068, 0.2433

7. The reliability of a communication channel is 0.40. How many channels should be placed in parallel redundancy so as to achieve the reliability of receiving the information is 0.80. If these channels are used to configure high level and low level redundant systems, what are the corresponding system reliabilities? Ans. 4, 0.2949, 0.4096

8. Which of the following systems has the higher reliability at the end of 100 hrs. of operation?
   (i) Two constant failure rates redundant components each having MTTF of 1000 hrs.
   (ii) A Weibull component with shape parameter of 2 and a characteristic life of 10000 hrs in series with a constant failure rates components with a failure rate of 0.00005.

   Ans. 0.9909, 0.9949