Indian Statistical Institute, Bangalore

M.S. (QMS) First Year

Second Semester - Reliability, Maintainability and Safety-II

Final Exam

Time: 3 hours Date: 24/04/2026 Maximum Marks: 50

1. A system consists of multiple subsystems with different failure rates and repair times.
    a) Define the maintainability function and derive it for an exponential repair time distribution.
    b) If the system has three subsystems with respective failure rates of 0.001, 0.002, and 0.003 per hour, and corresponding repair times of 2, 3, and 5 hours, respectively. If MTBF is 200 hours, compute the availability of the system.

[4 + 6 = 10]

2. Stress follows a normal distribution with mean *30* and standard deviation *6*, and strength initially follows a normal distribution with mean *50* and standard deviation *8*. However, due to wear, the mean strength decreases linearly with time according to $\mu(t) = 50 - 2t$.
    a) Find the reliability at $t = 5$.
    b) Determine the time t at which the reliability drops to 0.90.

[6 + 6 = 12]

3. A system experiences failure over time. Explain the concept of counting process. For a Homogeneous Poisson Process (HPP), show that expected number of failures is $E[N(t)] = \lambda t$.

[3 + 3 = 6]

4. Distinguish between renewal process and NHPP in terms of system restoration.

[4]

5. A system follows NHPP with intensity function $\lambda(t) = 0.01 + 0.003t$. Find the reliability between 8 to 10 hours.

[8]

6. A constant stress accelerated life test is conducted at three different stress levels. At each stress level, 10 identical items are placed on test. The experiment is terminated at a fixed censoring time of 10 hours for all stress levels. The observed failure times (in hours) are as follows:

   Stress level S_1(3 failures): 2.1, 4.5, 7.3

   Stress level S_2(5 failures): 1.2, 2.8, 3.6, 5.1, 8.4

   Stress level S_3(7 failures): 0.9, 1.5, 2.2, 3.0, 4.7, 6.3, 9.1

   Assume that at each stress level, the failure times follow an exponential distribution with parameter λ_i (for $i = 1,2,3$).

   a) Write down the likelihood function for the censored data at each stress level.

   b) Obtain the maximum likelihood estimates (MLEs) of the failure rates $\lambda_1, \lambda_2, \lambda_3$.

[5 + 5 = 10]