

**Indian Statistical Institute, Bangalore**

M.S (QMS) First Year

Second Semester - Reliability, Maintainability and Safety II

**Mid Term Exam**

Time: **2.5 Hours**

Date: **25 February, 2026**

Max Marks: **50**

1. Seven electronic units were subjected to a life test. Out of these, four units failed during the test period, while the remaining units were right-censored at the recorded times given in the table.

Table 1: Life Test Data for Electronic Equipment

Sl. No.	Observed time in hours	Status
1	8	Failed
2	16	Failed
3	18	Censored
4	25	Failed
5	28	Censored
6	36	Censored
7	40	Failed

- a. Obtain the Kaplan - Meier estimate of the reliability  
b. Plot the corresponding Kaplan - Meier survival curve based on the given data.

[6 + 4 = 10]

2. Consider a time-truncated life testing plan with termination time  $t_0$ , where the lifetime of each unit is denoted by  $T$ .

- a. Justify why the average testing time (ATT) is defined as  $E[\min(T, t_0)]$ .  
b. Let  $n$  items be placed on test, and assume that the lifetimes are independent and identically distributed exponential random variables with rate  $\lambda$ . The lot is rejected if at least  $r$  failures are observed before time  $t_0$ . Obtain the expression for the probability of lot acceptance as a function of  $\lambda$ ,  $r$ ,  $n$  and  $t_0$ .

[5 + 5 = 10]

3. Six leaf springs were subjected to an accelerated life test until failure. The recorded failure times (in cycles) are: 8712, 21915, 39400, 54613, 79000, and 110200. Assuming that the lifetimes are independent and identically distributed exponential random variables with rate parameter  $\lambda$ :
- Obtain the maximum likelihood estimate of  $\lambda$ .
  - Construct a 90% confidence interval for  $\lambda$ .

[5 + 5 = 10]

4. A coherent system consists of five independent components  $C_1, C_2, C_3, C_4, C_5$ . The minimal cut sets of the system are:  $K_1 = \{C_1, C_2\}$ ,  $K_2 = \{C_3\}$ ,  $K_3 = \{C_4, C_5\}$ . The component reliabilities are:  $R_1 = 0.90, R_2 = 0.85, R_3 = 0.92, R_4 = 0.88, R_5 = 0.80$ .
- Using the given minimal cut sets, draw the Reliability Block Diagram of the system.
  - Determine the structure function  $\phi(x_1, x_2, x_3, x_4, x_5)$  of the system.
  - Using the structure function and independence of components, compute the system reliability.

[2 + 3 + 5 = 10]

5. Write short notes on:
- Types of FMEA
  - Free replacement and prorated warranty.

[5 + 5 = 10]