[This question paper contains 2 printed pages.]

Your Roll No...............

Sr. No. of Question Paper : 7459 **L**

Unique Paper Code : 2373010019

Name of the Paper : DSE: Reliability Theory and Life Testing (NEP)

Name of the Course : **B.Sc. (H) Statistics**

Semester : VIII

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **five** questions.
3. **All** questions carry equal marks.
4. Use of any non-programmable calculator is allowed.

Q1(a) Define the following terms: (i) reliability function, (ii) hazard rate function, (iii) mean time to failure, and (iv) Interval Availability.

(b) Derive the reliability characteristics of the Gamma distribution and discuss its applicability in modelling life data.

Q2(a) Discuss the bathtub-shaped failure rate and provide a mathematical interpretation of its three phases. Let the hazard rate function be constant i.e. $h(t) = 0.05$. Find out the reliability function.

(b) Sixty items were placed on test and the test was terminated after the first 10 items failed. The failure times (in hours) were recorded as follows: 85, 151, 280, 376, 942, 520, 623, 715, 820 and 914. Assuming the life time distribution is given by the probability function

$$f(t) = \frac{1}{\theta} e^{-t/\theta}; \quad x, \theta > 0$$

Estimate θ and the reliability function R(t) at t = 600 hours if the failed items are (i) not replaced, and (ii) replaced with the new one.

Q3(a) Derive a uniformly minimum variance unbiased estimator (UMVUE) of the reliability function R(t) with a complete sample from an exponential distribution.

(b). Derive the maximum likelihood estimators of the parameters and the reliability function of the Weibull distribution based on a Type-II censored sample, assuming that both parameters are unknown.

Q4. What is meant by a mixture of k populations? Discuss it in detail with an illustrative example. For a mixture of 2 exponential populations, derive the maximum likelihood estimators of the parameters and the mixing proportions.

Q5(a). Develop the competing risks formulation for a system consisting of k components subject to mutually exclusive causes of failure.

(b). Explain the concept of stress–strength reliability. Derive the stress–strength reliability function for two independent continuous random variables. Also, if $X \sim Exp(\theta)$ and $Y \sim Exp(\lambda)$, then obtain stress-strength reliability.

Q6(a). Define a series system. Obtain its reliability function, mean lifetime and failure rate function, assuming that all the units are equally reliable and the reliability law is exponential.

(b). Define the concept of preventive maintenance (PM). Obtain an expression for the reliability and MTSF for a system when PM is performed on the system after every T hrs of its operation.

Q7(a). What is redundancy? Explain the concepts of active and standby redundancies with suitable examples.

(b). Define ageing classes and derive formal definitions of IFR, IFRA, NBU, NBUE and DMRL.