[This question paper contains 2 printed pages.]

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

Sr. No. of Question Paper : 7463 **L**

Unique Paper Code : 2373570009

Name of the Paper : DSE: Reliability Theory (NEP)

Name of the Course : **B.A. (P) / B.Sc. (P)**

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 **five** questions in all.
3. Question **1** is compulsory.
4. Use of a non-programmable scientific calculator is allowed.

1. Attempt any **six** parts.

(a) Explain k-out-of-m system reliability model.

(b) A system consists of 3 independent components in series. each having a reliability of 0.67. Obtain the reliability of the system. If the system complexity is increased so that it contains 5 of these components, obtain the reliability of the new system.

(c) Explain Stress- strength model in reliability.

(d) Define hazard rate function and reverse hazard rate function.

(e) Find reliability of a 2-out-of-3 system with component reliability 0.8.

(f) Let the time to failure components be exponentially distributed with parameter λ_i, i = 1, 2, ..., n for a system with n components in series. Obtain the reliability of the system.

(g) The reliability function of a component is given by:

$$R(t) = e^{-0.5t}$$

Determine the corresponding hazard rate function.

(6 × 3 = 18)

2. **(a)** Suppose n items are under test with replacements and the failure time distribution is exponential with mean life θ, then prove that the between failure times are i.i.d. as exponential distribution with mean life time θ /n.

(b) A component has lifetime as $f(t) = 0.5e^{-0.5t}$; $t \geq 0$. Obtain the reliability function, hazard rate and MTTF.

(c) Suppose that the failure time distribution follows a Gamma distribution with scale parameter λ =0.5 and shape parameter ν=2, find the mean, variance and the coefficient of variation.

(6, 6, 6)

3. **(a)** Let the failure time **T** follow Weibull distribution with density:

$f(t) = \frac{p}{\theta} t^{p-1} e^{\frac{-t^p}{\theta}}, \theta > 0$, p > 0, t > 0, where p is the shape parameter and θ is the scale parameter. Obtain the maximum likelihood estimate of θ under failure censoring when parameter p is known. Further, obtain the maximum likelihood estimate of θ under a complete sampling scheme.

(b) Strength X and Stress Y follow independent Weibull distributions with parameters $(\alpha_X = 2, \beta_X = 100)$ $and (\alpha_Y = 2, \beta_Y = 80)$ respectively. Compute R = P (X > Y) numerically. **(12, 6)**

4. **(a)** Suppose that the failure time distribution follows exponential distribution with $\theta = 0.75$. Obtain the mean and variance of failure time. Also obtain the probability of surviving at most 1.5 years.

(b) A system has 2 components in parallel, each with reliability 0.95. Obtain the reliability of the system and also the incremental reliability if one more unit is added to the system having 4 units. The probability of success for each component is 0.6.

(c) Prove that in case of constant failure rates the improvement in the mean life through redundancy is logarithmic. **(6, 6, 6)**

5. **(a)** Suppose n items are put to test and the test is terminated (without replacement) as soon as the first $r \le n$ failure times $x_{(1)} < x_{(2)} < \ldots < x_{(r)}$ are recorded. The failure times follow exponential distribution with parameter θ .Obtain the maximum likelihood estimator of $\frac{1}{\theta}$ and also find UMVUE of $\frac{1}{\theta}$.

(b) Obtain the reliability function for

(i) 3-out-of-4 systems:

(ii) simple 3-unit parallel system where the probability of success for each component is 0.7. **(12, 6)**

6. Write short notes on **any four** of the following:

(i) Parallel system reliability

(ii) Standby Redundancy

(iii) Mean inactive time

(iv) Proportional reverse hazard rate model

(v) Time censored sampling **(4 × 4.5 = 18)**