[This question paper contains 2 printed pages.]

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

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Sr. No. of Question Paper	:	**8141**
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) Show that for an exponential distribution with mean θ, hazard rate is constant.

(b) Consider a failure model with failure time of a certain component having a Weibull distribution with shape parameter λ=0.5 and scale parameter γ=2. Show that the hazard function is of decreasing function.

(c) Obtain the reliability function of a system having two components when (i) units are operating in parallel, (ii) units are operating in series. The probability of success for each component is 0.6.

(d) Suppose a certain system works normally at 2 out-of-4 systems but due to some requirement the system has to work as 3-out-of-4 systems. Will there be a change in the reliability of the system? If yes, obtain the difference for p=0.9.

(e) Consider a four-component system whose components are i.i.d. with constant failure rate λ_i, i=1, 2, ..., 4. If R(100) = 0.95 is the specified reliability, find the individual component mean time to failure.

(f) State the difference between mean time to failure and mean time between failures.

Consider the pdf $f(t)=\frac{0.001}{(1+0.001t)^2}$, $t \geq 0$,

$=0$, elsewhere,

with t measured in hours. Obtain the reliability for a 100 hours operating life.

(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)** Let the failure time T follow a Weibull distribution with density;

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

where p is the shape parameter and θ is the scale parameter. Obtain the maximum likelihood estimates of θ and p, under failure censored sampling scheme where the experiment is terminated after r failures and both θ and p are unknown.

(b) Explain bath-tub shaped hazard rate model and obtain the reliability function for the model. **(12, 6)**

3. **(a)** Let the failure time T follow a two-parameter Gamma distribution with shape parameter λ and scale parameter ν having the density function $f(t) = \frac{\nu^{\lambda} e^{-\nu t} t^{\lambda-1}}{\Gamma(\lambda)}, \lambda > 0, \nu > 0, t > 0.$

   Obtain the hazard rate function, reliability function and the mean time to failure of the system.

   (b) Suppose that the failure time distribution follows a Weibull distribution with scale parameter $\lambda = 1$ and shape parameter $\nu = 0.5$, find the mean, variance and the coefficient of variation of the failure time. **(12, 6)**

4. **(a)** Obtain the reliability function for the systems with
   (i) components in series,
   (ii) components in parallel.

   (b) Obtain the reliability function for
   (i) 2-out-of-3 systems
   (ii) simple 3unit parallel system where the probability of success for each component is 0.9. **(12, 6)**

5. **(a)** Let the failure time T follow an exponential distribution with mean θ. then obtain the UMVUE of θ and the hazard rate function under time censored sampling scheme.

   (b) Obtain the reliability of the model where the strength X and Stress Y follow independent exponential distribution with mean $\frac{1}{\lambda_1}$ and $\frac{1}{\lambda_2}$ respectively. **(12, 6)**

6. Write short notes on **any four** of the following:
   (a) Components and system
   (b) Failure censored samples
   (c) k-out-of-m systems
   (d) Redundancy in reliability model
   (e) New better than used life distribution and decreasing failure rate life distribution. **$(4 \times 4.5 = 18)$**