Roll No. .....

Question Booklet Number

O. M. R. Serial No. | | | | | | | |

M. Sc. (Second Semester)

(NEP) EXAMINATION, 2025-26

STATISTICS

(Reliability Theory and Life Distributions) (Elective)

Paper Code							
B	0	6	0	8	0	4	T

Questions Booklet Series
B

Time : 1:30 Hours] [*Maximum Marks : 75*

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.

2. The booklet contains 100 questions. Examinee is required to answer 75 questions in the OMR Answer-Sheet provided and not in the question booklet. All questions carry equal marks.

3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be got immediately replaced.

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।

2. प्रश्न-पुस्तिका में 100 प्रश्न हैं। परीक्षार्थी को 75 प्रश्नों को केवल दी गई OMR आन्सर-शीट पर ही हल करना है, प्रश्न-पुस्तिका पर नहीं। सभी प्रश्नों के अंक समान हैं।

3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR आन्सर-शीट को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका जिसमें कुछ भाग छपने से छूट गए हों या प्रश्न एक से अधिक बार छप गए हों या उसमें किसी अन्य प्रकार की कमी हो, तो उसे तुरन्त बदल लें।

(Remaining instructions on the last page) **(शेष निर्देश अन्तिम पृष्ठ पर)**

(Only for Rough Work)

1. Which distribution has a "Heavy Tail" ?

(A) Exponential

(B) Normal

(C) Lognormal

(D) Uniform

2. In a series system, the system failure rate is the :

(A) Product of component failure rates

(B) Sum of component failure rates

(C) Maximum of component failure rates

(D) Minimum of component failure rates.

3. The cumulative hazard function H(t) is defined as :

(A) $\int_0^t h(u)du$

(B) $h(t)^2$

(C) $1 - e^{-h(t)}$

(D) $d/dt[h(t)]$

4. Which software/method is commonly used for parameter estimation of complex life distributions ?

(A) Least Squares

(B) Maximum Likelihood Estimation (MLE)

(C) Method of Moments

(D) All of the above

5. A redundant system is designed to :

(A) Increase failure rate

(B) Decrease cost only

(C) Increase reliability

(D) Simplify the design

6. "Burn-in" testing is intended to eliminate :

(A) Wear-out failures

(B) Early life (infant mortality) failures

(C) Random failures

(D) Standard failures

7. If the components in a parallel system are identical with reliability p, the system reliability is :

(A) p^n

(B) $1 - (1 - p)^n$

(C) np

(D) $1 - p^n$

8. For an Exponential distribution, the hazard rate is :

(A) t

(B) $1/t$

(C) λ

(D) λ^2

9. The survival function of a Weibull distribution is :

(A) $e^{-(t/\alpha)^{\beta}}$

(B) $1-e^{-(t/\alpha)^{\beta}}$

(C) $(t/\alpha)^{\beta}$

(D) $\beta \ln(t)$

10. The "Mean Time To Repair" (MTTR) is a measure of :

(A) Reliability

(B) Maintainability

(C) Quality

(D) Durability

11. In a coherent system, adding a component to a minimal path set :

(A) Always decreases reliability

(B) Never decreases reliability

(C) Makes the system fail

(D) Has no effect

12. In a coherent system, removing a component from a minimal cut set :

(A) Never increases reliability

(B) Always increases reliability

(C) Is impossible

(D) Results in a series system

13. The distribution of the time between successive renewals in a renewal process is :

(A) Always exponential

(B) The underlying life distribution F(t)

(C) Always normal

(D) Uniform

14. Estimation of reliability involves :

(A) Point estimation

(B) Interval estimation

(C) Both (A) and (B)

(D) Neither (A) nor (B)

15. Truncated experiments for exponential models are used in :

(A) Basic configuration studies

(B) Life testing problems

(C) Maintenance scheduling

(D) Cost estimation only

16. The "Scale Parameter" in an exponential distribution (λ) affects the :

(A) Shape of the curve

(B) Spread or "stretch" of the distribution

(C) Starting point on the x-axis

(D) Symmetry

17. Which distribution is frequently used for modeling the life of electronic components ?

(A) Weibull
(B) Exponential
(C) Gamma
(D) All of the above

18. The probability density function $f(t)$ is the derivative of :

(A) $R(t)$
(B) $F(t)$
(C) $h(t)$
(D) $H(t)$

19. A system with n components has 2^n possible states. This is used in :

(A) Reliability Block Diagrams
(B) State Space Analysis
(C) Fault Tree Analysis
(D) All of the above

20. Common problems in life testing specifically mention :

(A) Exponential models
(B) Binomial models
(C) Beta models
(D) Poisson models

21. If $h(t)$ is increasing, the distribution is said to be :

(A) IFR (Increasing Failure Rate)
(B) DFR (Decreasing Failure Rate)
(C) Constant
(D) Exponential

22. If $h(t)$ is decreasing, the distribution is said to be :

(A) IFR
(B) DFR
(C) Normal
(D) Balanced

23. The variance of a Weibull distribution depends on :

(A) Only α
(B) Only β
(C) Both α and β
(D) Neither α nor β

24. The "memoryless property" implies $P(T > s + t \mid T > s) =$:

(A) $P(T > s)$
(B) $P(T > t)$
(C) $P(T > s)\ P(T > t)$
(D) $P(T < t)$

25. The reliability of a series system is always :

(A) Greater than the reliability of its best component
(B) Less than or equal to the reliability of its worst component
(C) Equal to 0.5
(D) 1

26. The reliability of a parallel system is always :

(A) Greater than or equal to the reliability of its best component

(B) Less than the reliability of its worst component

(C) Equal to the sum of reliabilities

(D) 0

27. What is the structure function $\phi(x)$ for a 2-out-of-3 system ?

(A) $x_1 x_2 x_3$

(B) $x_1 x_2 + x_2 x_3 + x_3 x_1 - 2x_1 x_2 x_3$

(C) $x_1 + x_2 + x_3$

(D) $1-(1-x_1)(1-x_2)(1-x_3)$

28. Life testing experiments are often censored because :

(A) Of time and cost constraints

(B) All items are expected to fail immediately

(C) Data is naturally normal

(D) It is required by law

29. The MLE of the reliability function for an exponential distribution is :

(A) $e^{-\hat{\lambda}t}$

(B) $1-e^{-\hat{\lambda}t}$

(C) $\hat{\lambda}t$

(D) $1/\hat{\lambda}$

30. Renewal density $m(t)$ satisfies the integral equation :

(A) $m(t) = f(t) + \int_0^t m(t-u) f(u) du$

(B) $m(t) = \mathrm{R}(t)$

(C) $m(t) = \int f(t) dt$

(D) $m(t) = 1/f(t)$

31. For a Normal distribution, the failure rate $h(t)$ is :

(A) Constant

(B) Decreasing

(C) Monotonically increasing

(D) U-shaped

32. The term "Complete Sample" means :

(A) All items in the test failed and their failure times were recorded

(B) Only half of the items failed

(C) No items failed

(D) The sample size was over 100

33. In the context of renewal theory, the "Elementary Renewal Theorem" states that $M(t)/t$ approaches :

(A) $1/\mu$ (where μ is mean life)

(B) μ

(C) 0

(D) 1

34. A component is “relevant” if :

(A) Its state can change the state of the system

(B) It is expensive

(C) It is in a series configuration

(D) It is made of metal

35. $H(t) = -\ln [R(t)]$ defines the :

(A) Reliability function

(B) Cumulative hazard function

(C) Probability density function

(D) Hazard rate

36. Which distribution is appropriate for “waiting time” problems ?

(A) Normal

(B) Exponential

(C) Uniform

(D) Cauchy

37. The Lognormal distribution is used when the failure is due to :

(A) Sum of small effects

(B) Product of many small independent factors

(C) A single major factor

(D) Constant wear

38. Which group of failure models is commonly used to analyze life distributions and the physical phenomena of aging ?

(A) Poisson, Geometric, and Binomial

(B) Exponential, Weibull, Normal, and Lognormal

(C) Cauchy, Laplace, and Pareto

(D) Uniform, Beta, and Chi-square

39. If a system is series-parallel, you should evaluate the reliability by :

(A) Reducing series and parallel subsystems step-by-step

(B) Only using the series formula

(C) Ignoring the parallel parts

(D) Adding all reliabilities

40. Estimation of parameters for a Gamma distribution is generally :

(A) Easier than Exponential

(B) More complex than Exponential (often requiring numerical methods)

(C) Impossible

(D) Done using a simple ruler

41. The "Failure rate" $h(t)$ for a series system of n independent components with failure rates $h_i(t)$ is :

(A) $\prod h_i(t)$

(B) $\sum h_i(t)$

(C) $\max h_i(t)$

(D) $1/\sum h_i(t)$

42. In Type II censoring, the number of failures r is :

(A) Random

(B) Predetermined (fixed)

(C) Infinite

(D) Zero

43. The "renewal function" $M(t)$ for an exponential distribution with rate λ is :

(A) λt

(B) $e^{\lambda t}$

(C) $1-e^{-\lambda t}$

(D) $\lambda^2 t$

44. The structure function of a system is a mapping from $\{0, 1\}^n$ to :

(A) $\{0, 1\}$

(B) Real numbers

(C) Complex numbers

(D) $[-1, 1]$

45. A "Life Distribution" is a probability distribution of a :

(A) Positive random variable

(B) Negative random variable

(C) Discrete variable only

(D) Categorical variable

46. "Applied Life Data Analysis" is a book by :

(A) Sinha

(B) Nelson

(C) Bain

(D) Lawless

47. Measures of reliability include :

(A) Mean time to failure

(B) Reliability function

(C) Hazard rate

(D) All of the above

48. The shape of the Exponential distribution is always :

(A) Bell-shaped

(B) Decaying

(C) Rectangular

(D) Bimodal

49. A system where $k = 1$ in a k-out-of-n configuration is a :

(A) Series system

(B) Parallel system

(C) Coherent system with one path

(D) Failed system

50. A system where $k = n$ in a k-out-of-n configuration is a :

(A) Series system

(B) Parallel system

(C) Redundant system

(D) Coherent system with n paths

51. Reliability is defined as the probability that a system will perform its intended function under stated conditions for a :

(A) Minimum cost

(B) Specified period of time

(C) Maximum load

(D) Infinite duration

52. The reliability function $R(t)$ is related to the cumulative distribution function $F(t)$ by :

(A) $R(t) = F(t)$

(B) $R(t) = 1 + F(t)$

(C) $R(t) = 1 - F(t)$

(D) $R(t) = \int F(t)dt$

53. In a series system of n independent components, the system reliability is :

(A) The sum of individual reliabilities

(B) The product of individual reliabilities

(C) The average of individual reliabilities

(D) Equal to the reliability of the weakest component

54. For a parallel system to fail :

(A) At least one component must fail

(B) Exactly half of the components must fail

(C) All components must fail

(D) The first component must fail

55. The hazard rate $h(t)$ is also known as the :

(A) Survival rate

(B) Instantaneous failure rate

(C) Mean time to failure

(D) Cumulative failure probability

56. If the failure rate is constant over time, the underlying life distribution is :

(A) Normal

(B) Weibull

(C) Exponential

(D) Gamma

57. A "Bathtub Curve" represents the failure rate across the life cycle. The middle flat portion represents :

(A) Infant mortality

(B) Wear-out phase

(C) Useful life phase

(D) Burn-in period

58. Which of the following is a measure of the average time a non-repairable system operates before failure ?

(A) MTTR

(B) MTBF

(C) MTTF

(D) MDT

59. In a Coherent System, which of the following must be true ?

(A) Every component is relevant to the system

(B) The structure function is non-decreasing

(C) Redundancy is prohibited

(D) Both (A) and (B)

60. The structure function $\phi(x)$ of a series system of 3 components is :

(A) $x_1 + x_2 + x_3$

(B) $\max(x_1, x_2, x_3)$

(C) $x_1 \cdot x_2 \cdot x_3$

(D) $1 - (1 - x_1)(1 - x_2)(1 - x_3)$

61. A parallel system of two components with reliabilities p_1 and p_2 has a system reliability of :

(A) $p_1 p_2$

(B) $p_1 + p_2 - p_1 p_2$

(C) $1 - p_1 p_2$

(D) $(p_1 + p_2)/2$

62. The Weibull distribution is versatile because its shape parameter β can model :

(A) Decreasing failure rates ($\beta < 1$)

(B) Constant failure rates ($\beta = 1$)

(C) Increasing failure rates ($\beta > 1$)

(D) All of the above

63. Which distribution is often used to model the life of products where failures occur due to the fatigue-stress process ?

(A) Lognormal

(B) Binomial

(C) Poisson

(D) Uniform

64. The memoryless property is a unique characteristic of which distribution ?

(A) Normal

(B) Exponential

(C) Gamma

(D) Weibull

65. If a system has a constant failure rate λ, its reliability at time t is :

(A) λt

(B) $e^{-\lambda t}$

(C) $1 - e^{-\lambda t}$

(D) $1/\lambda$

66. In censored sampling, Type I censoring occurs when :

(A) The experiment stops after a fixed number of failures

(B) The experiment stops at a predetermined time

(C) The experiment continues until all units fail

(D) Half of the units are removed randomly

67. Type II censoring is also known as :

(A) Time-truncated censoring

(B) Failure-terminated censoring

(C) Random censoring

(D) Progressive censoring

68. The Renewal Function M(t) represents the :

(A) Probability of no failures by time t

(B) Expected number of renewals (failures) in (0, t]

(C) Time until the next failure

(D) Reliability of a repaired system

69. For a Gamma distribution with shape parameter α and scale parameter β, if $\alpha = 1$, it becomes :

(A) A normal distribution

(B) A weibull distribution

(C) An exponential distribution

(D) A lognormal distribution

70. The "Mean Residual Life" (MRL) at time t is :

(A) The total life of the component

(B) The expected remaining life given it has survived until t

(C) The time already spent in operation

(D) The reciprocal of the hazard rate

71. A system is "Coherent" if its structure function is :

(A) Monotone and every component is relevant

(B) Constant and independent of components

(C) Linear and strictly increasing

(D) Based only on parallel configurations

72. A Minimal Path Set is a set of components whose functioning ensures system functioning, and :

(A) It contains all components

(B) No subset of it is a path set

(C) It is the largest possible path set

(D) It must be a series configuration

73. A Minimal Cut Set is a set of components whose failure causes system failure, and :

(A) It contains at least five components

(B) No subset of it is a cut set

(C) It ensures the system never fails

(D) It is only applicable to series systems

74. For a Lognormal distribution, the natural logarithm of the variable follows a :

(A) Weibull distribution

(B) Normal distribution

(C) Gamma distribution

(D) Beta distribution

75. In life testing, "Truncated experiments" refer to :

(A) Tests where data is lost due to recording errors

(B) Tests ended before all items have failed

(C) Tests where the sample size is increased mid-way

(D) Tests conducted at extremely high temperatures

76. The Renewal Density is the :

(A) Derivative of the renewal function M(t)

(B) Integral of the reliability function

(C) Probability of a system never failing

(D) Mean time between repairs

77. Which distribution is commonly used to model wear-out phases where the failure rate increases over time ?

(A) Exponential

(B) Weibull with $\beta > 1$

(C) Uniform

(D) Cauchy

78. If T follows an Exponential distribution with mean $1/\lambda$, the variance is :

(A) $1/\lambda$

(B) $1/\lambda^2$

(C) λ

(D) λ^2

79. The Maximum Likelihood Estimator (MLE) for the parameter λ of an Exponential distribution under a complete sample of n items is :

(A) $\Sigma T_i/n$

(B) $n/\Sigma T_i$

(C) $\max(T_i)$

(D) $\min(T_i)$

80. In k-out-of-n system, the system works if :

(A) Exactly k components work

(B) At most k components work

(C) At least k components work

(D) No components fail

81. A series system of 10 components, each with reliability 0.9, has a total reliability of :

(A) 0.9

(B) 0.09

(C) $(0.9)^{10}$

(D) $1 - (0.1)^{10}$

82. A parallel system of 2 components, each with reliability 0.9, has a total reliability of :

(A) 0.81

(B) 0.90

(C) 0.99

(D) 1.80

83. Hazard rate $h(t)$ is calculated as :

(A) $F(t)/R(t)$

(B) $f(t)/R(t)$

(C) $R(t)/f(t)$

(D) $1/R(t)$

84. The area under the probability density function $f(t)$ from 0 to ∞ is :

(A) 0

(B) 0.5

(C) 1

(D) ∞

85. If the hazard rate is $h(t) = \lambda$, the reliability function is :

(A) λt

(B) $1 - \lambda t$

(C) $e^{-\int \lambda dt}$

(D) $\ln(\lambda t)$

86. The Lognormal distribution is skewed to the :

(A) Left

(B) Right

(C) Not skewed (Symmetric)

(D) Depends on the mean

87. Which of the following is NOT a property of a Reliability Function ?

(A) $R(0) = 1$

(B) $R(\infty) = 0$

(C) It is non-increasing

(D) It is always greater than 1

88. "Renewal Function" is associated with :

(A) Non-repairable systems

(B) Repairable systems (stochastic point processes)

(C) Systems that never fail

(D) Only series systerns

89. For the Weibull distribution $f(t) = \frac{\beta}{\alpha}\left(\frac{t}{\alpha}\right)^{\beta-1} e^{-(t/\alpha)^{\beta}}$, α is the :

(A) Shape parameter

(B) Scale parameter

(C) Location parameter

(D) Failure rate

90. If the shape parameter $\beta = 2$ in a Weibull distribution, the failure rate is :

(A) Constant

(B) Decreasing

(C) Linearly increasing

(D) Exponentially increasing

91. The relationship $\text{MTTF} = \int_0^{\infty} R(t)dt$ holds for :

(A) Only Exponential distributions

(B) Only Normal distributions

(C) Any non-negative continuous random variable

(D) Only censored data

92. Which author is associated with the reference "Statistical Theory of Reliability and Life Testing" ?

(A) Crowder

(B) Barlow and Proschan

(C) Nelson

(D) Balagurusamy

93. A structure function $\phi(x)$ takes values :

(A) Between –1 and 1

(B) 0 or 1

(C) Any real number

(D) Only positive integers

94. If $\phi(x) = 1$, the system is in a/an :

(A) Failed state

(B) Working state

(C) Maintenance state

(D) Unknown state

95. Bridge structures are examples of :

(A) Simple series systems

(B) Simple parallel systems

(C) Complex (neither strictly series nor parallel) systems

(D) Coherent systems with only one component

96. Type I censoring is also called :

(A) Right censoring

(B) Left censoring

(C) Interval censoring

(D) Mid-point censoring

97. In Type II censoring, the test duration T is :

(A) Fixed

(B) A random variable

(C) Always 100 hours

(D) Zero

98. Parameter estimation for the Lognormal distribution usually involves :

(A) Direct integration

(B) Transformation to the Normal distribution

(C) Only graphical methods

(D) Ignoring the variance

99. The failure rate of a Gamma distribution for shape parameter $\alpha > 1$ is :

(A) Constant

(B) Monotonically increasing to a limit

(C) Monotonically decreasing to zero

(D) U-shaped

100. Reliability R(t) can be interpreted as :

(A) $P(T > t)$

(B) $P(T < t)$

(C) $P(T = t)$

(D) $P(T \neq t)$

(Only for Rough Work)

4. Four alternative answers are mentioned for each question as—A, B, C & D in the booklet. The candidate has to choose the correct answer and mark the same in the OMR Answer-Sheet as per the direction :

Example :

Question :

Q. 1 (A) ● (C) (D)
Q. 2 (A) (B) ● (D)
Q. 3 (A) ● (C) (D)

Illegible answers with cutting and over-writing or half filled circle will be cancelled.

5. Each question carries equal marks. Marks will be awarded according to the number of correct answers you have.
6. All answers are to be given on OMR Answer Sheet only. Answers given anywhere other than the place specified in the answer sheet will not be considered valid.
7. Before writing anything on the OMR Answer Sheet, all the instructions given in it should be read carefully.
8. After the completion of the examination candidates should leave the examination hall only after providing their OMR Answer Sheet to the invigilator. Candidate can carry their Question Booklet.
9. There will be no negative marking.
10. Rough work, if any, should be done on the blank pages provided for the purpose in the booklet.
11. To bring and use of log-book, calculator, pager and cellular phone in examination hall is prohibited.
12. In case of any difference found in English and Hindi version of the question, the English version of the question will be held authentic.

Impt. : On opening the question booklet, first check that all the pages of the question booklet are printed properly. If there is any discrepancy in the question Booklet, then after showing it to the invigilator, get another question Booklet of the same series.

4. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार सम्भावित उत्तर—A, B, C एवं D हैं। परीक्षार्थी को उन चारों विकल्पों में से सही उत्तर छाँटना है। उत्तर को OMR आन्सर-शीट में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

उदाहरण :

प्रश्न :

प्रश्न 1 (A) ● (C) (D)
प्रश्न 2 (A) (B) ● (D)
प्रश्न 3 (A) ● (C) (D)

अपठनीय उत्तर या ऐसे उत्तर जिन्हें काटा या बदला गया है, या गोले में आधा भरकर दिया गया, उन्हें निरस्त कर दिया जाएगा।

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।
6. सभी उत्तर केवल ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर ही दिये जाने हैं। उत्तर-पत्रक में निर्धारित स्थान के अलावा अन्यत्र कहीं पर दिया गया उत्तर मान्य नहीं होगा।
7. ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर कुछ भी लिखने से पूर्व उसमें दिये गये सभी अनुदेशों को सावधानीपूर्वक पढ़ लिया जाये।
8. परीक्षा समाप्ति के उपरान्त परीक्षार्थी कक्ष निरीक्षक को अपनी OMR Answer Sheet उपलब्ध कराने के बाद ही परीक्षा कक्ष से प्रस्थान करें। परीक्षार्थी अपने साथ प्रश्न-पुस्तिका ले जा सकते हैं।
9. निगेटिव मार्किंग नहीं है।
10. कोई भी रफ कार्य, प्रश्न-पुस्तिका के अन्त में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।
11. परीक्षा-कक्ष में लॉग-बुक, कैलकुलेटर, पेजर तथा सेल्युलर फोन ले जाना तथा उसका उपयोग करना वर्जित है।
12. प्रश्न के हिन्दी एवं अंग्रेजी रूपान्तरण में भिन्नता होने की दशा में प्रश्न का अंग्रेजी रूपान्तरण ही मान्य होगा।

महत्वपूर्ण : प्रश्नपुस्तिका खोलने पर प्रथमतः जाँच कर देख लें कि प्रश्न-पुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरीज की दूसरी प्रश्न-पुस्तिका प्राप्त कर लें।