1. For the linear model, $y_{ij} = \mu + \alpha_i + \beta_j + e_{ij}$, i = 1, 2, . . . , m, j = 1, 2, . . , n, which of the following assumptions is not true ?
   (A) The experimental data are homogeneous
   (B) The errors e_{ij}'s are i.i.d.
   (C) The common distribution of e_{ij}'s is $N\left(0, \sigma_e^2\right)$
   (D) The effects are additive in nature

2. Which of the following is not associated with analysis of variance ?
   (A) Critical difference
   (B) Duncan's test
   (C) Tukey's test
   (D) χ^2 - test

3. To test the equality of treatment means in ANOVA, which of the following test is used ?
   (A) χ^2 - test
   (B) t-test
   (C) F-test
   (D) standard normal test

4. Which of the following principles of experimental design is/are used in CRD ?
   (A) randomization only
   (B) replication only
   (C) local control and randomization
   (D) randomization and replication

5. In CRD with t treatments based on n experimental units, the error d.f. is
   (A) n – 1
   (B) t – 1
   (C) n – t
   (D) n – t + 1

6. The error sum of squares in RBD as compared to CRD using the same material is
   (A) more
   (B) less
   (C) equal
   (D) unequal

7. Confounding is a technique to reduce
   (A) block size
   (B) replication
   (C) errors
   (D) error d.f.

8. The number of LSD's of order m which can be constructed such that they are orthogonal to each other is
   (A) m
   (B) atmost m – 1
   (C) atmost m
   (D) m – 1

9. Suppose a BIBD with parameters υ, b, r, k, λ is available. Then which of the following cases is not possible ?
   (A) $\upsilon r = bk$
   (B) $b < \upsilon$
   (C) $\lambda(\upsilon - 1) = r(k - 1)$
   (D) $b \geq \upsilon$

10. Let there be 5 units in the population, numbered from 1 to 5. If a simple random sample of size 3 without replacement is drawn from the population, what is the probability that unit 5 is included in the sample ?
    (A) $\frac{1}{5}$
    (B) $\frac{3}{5}$
    (C) $\frac{2}{5}$
    (D) $\frac{1}{3}$

11. Which variety of an incomplete block design has the following relationship : $b = v + r - 1$ between their parameters ?

(A) Symmetrical BIBD
(B) Resolvable BIBD
(C) Affine resolvable BIBD
(D) PBIBD

12. Consider the following statements :

1) Non sampling errors occur in complete enumeration only.
2) Increase in the sample size usually results in the decrease in sampling error.
3) In a sample survey, non sampling errors may also arise due to the defective frame.

Which of the above statements are true ?

(A) 1 and 2
(B) 1 and 3
(C) 2 and 3
(D) 1, 2 and 3

13. In estimating population mean based on a stratified sample with maximum precision for a fixed cost, take a large sample from a stratum if

(A) the stratum is larger
(B) sampling is cheaper in the stratum
(C) the stratum is more variable internally
(D) conditions in either (A), (B) and (C) or all simultaneously hold

14. Which of the following cases of systematic sampling with interval k, systematic sample mean is not an unbiased estimator of the population mean ?

(A) linear sampling with $N = nk$
(B) linear sampling with $N \neq nk$
(C) circular sampling with $N = nk$
(D) circular sampling with $N \neq nk$

15. In SRSWOR of n clusters each containing M elements from a population of N clusters, variance of the estimator of the population mean depends on

(A) n and M
(B) population mean square, S^2
(C) intraclass correlation coefficient, ρ_c
(D) n, M, S^2 and ρ_c

16. In which of the sampling schemes/estimation methods, information on the auxiliary variate which is highly correlated with the study variate cannot be used ?

(A) Ratio and regression methods
(B) PPS sampling
(C) Stratified sampling
(D) Systematic sampling

17. Let $X \sim P(\lambda)$. Then an unbiased estimator of $e^{-\lambda}$ based on a single observation X_1 is given by

(A) $\delta(X_1) = \begin{cases} 1, & \text{if } X_1 = 0 \\ 0, & \text{otherwise} \end{cases}$
(B) $\delta^*(X_1) = \begin{cases} 1, & \text{if } X_1 \geq 1 \\ 0, & \text{otherwise} \end{cases}$
(C) X_1
(D) e^{-X_1}

18. Let $X_1, X_2, \ldots, X_n$ be a random sample of size n from $N(\mu, \sigma^2)$. Let $S^2 = \sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{n-1}$

Consider the following statements :

1) S^2 is unbiased for σ^2, but S is not unbiased for σ.

2) S^2 is consistent for σ^2, but S is not consistent for σ.

Which of these statements is/are true ?

(A) 1 only (B) 2 only

(C) both 1 and 2 (D) none of the above

19. Which of the following theorems provides the unique UMVUE of a parameter ?

(A) Basu's (B) Rao-Blackwell

(C) Lehmann-Scheffe (D) Cramer's

20. Which of the following families of distributions does not belong to the one-parameter exponential family ?

(A) Poisson (B) Normal with one parameter known

(C) Geometric (D) Uniform over $(0, \theta)$

21. An unbiased estimator which attains the Cramer-Rao lower bound is known as

(A) Consistent estimator (B) MVB estimator

(C) Asymptotically efficient estimator (D) UMVUE

22. Which of the following is not true ?

(A) ML estimator is the MVB estimator, if it exists

(B) If a unique ML estimator exists, it is a function of a sufficient statistic

(C) If UMVUE of θ exists then it is same as the ML estimator

(D) ML estimator need not be unbiased

23. Which one among the following distributions is not admitting a single sufficient statistic ?

(A) Uniform distribution over $(-\theta, \theta)$

(B) Normal distribution with mean θ

(C) Poisson distribution with parameter θ

(D) Cauchy distribution with location parameter θ

24. Let T_1 and T_2 be two unbiased estimators for θ. Suppose T_1 is a MVUE. If e is the efficiency of T_2 w.r.t. T_1, then the correlation coefficient between T_1 and T_2 is

(A) $e^{-1/2}$ (B) $e^{1/2}$ (C) e^{-1} (D) e

25. Consider the following statements regarding moment estimators.

1) Estimators obtained by the method of moments are unbiased.

2) Estimators obtained by the method of moments are generally consistent.

Which of these is/are true ?

(A) 1 only (B) 2 only (C) both (D) none

26. Fisher-Neymann criterion for sufficiency is used
    (A) to show that a given statistic is sufficient or not
    (B) to show that a given statistic is complete sufficient
    (C) to answer the question of whether a family admits a best estimator for the parameter
    (D) to answer whether a given estimator is admissible

27. For the SPRT of strength (α, β), which of the following inequalities is satisfied by the stopping bounds A and B (A > B) ?
    (A) $A \geq \frac{1-\beta}{\alpha}, B \leq \frac{\beta}{1-\alpha}$
    (B) $A \leq \frac{1-\beta}{\alpha}, B \geq \frac{\beta}{1-\alpha}$
    (C) $A \geq \frac{1-\alpha}{\beta}, B \leq \frac{\alpha}{1-\beta}$
    (D) $A \leq \frac{1-\alpha}{\beta}, B \geq \frac{\alpha}{1-\beta}$

28. The mean of 9 observations drawn at random from a normal population with mean μ and standard deviation 9 is 18. What is the shortest 95% confidence interval for μ ?
    (A) (9, 27)
    (B) (15, 21)
    (C) (13.05, 22.95)
    (D) (12.12, 23.88)

29. Which of the following is correct for taking a decision of rejecting/accepting a null hypothesis H_0 using the P-value ?
    (A) Smaller the P-value, weaker evidence against H_0
    (B) Smaller the P-value, stronger evidence against H_0
    (C) Smaller the P-value, weaker evidence in favour of H_0
    (D) Smaller the P-value, stronger evidence in favour of H_0

30. To test $H_0 : \lambda = 1$ Vs. $H_1 : \lambda = 2$ based on a single observation from $P(\lambda)$, the test function is given by $\phi(x) = \begin{cases} 1, & \text{if } x > 2 \\ 0, & \text{otherwise} \end{cases}$. Then power of the test is
    (A) $1-\frac{5}{e^2}$
    (B) $\frac{5}{e^2}$
    (C) $1-\frac{5}{2e}$
    (D) $\frac{5}{2e}$

31. For a population distribution, Kolmogorov-Smirnouv one sample test is used for testing its
    (A) location
    (B) symmetry
    (C) location and symmetry
    (D) goodness of fit

32. For the sample values, X_i: 1, 2, 3, 5, 7, 9, 11, 18 and Y_i: 4, 6, 8, 10, 12, 13, 15, 19, the value of the Mann-Whitney U-statistic for testing H_0 : The populations are identically the same is
    (A) 54
    (B) 51
    (C) 47
    (D) 17

33. If X~ binomial (50, 0.52) then the distribution is
    (A) symmetric
    (B) + vely skewed
    (C) – vely skewed
    (D) cannot say anything about the symmetry of the distribution

34. Binomial distribution with parameters (n, p) tends to Poisson distribution with mean λ if
    (A) $n \to \infty$
    (B) $p \to 0$
    (C) $np = \lambda$
    (D) conditions in (A), (B) and (C) simultaneously hold

35. The β_1-coefficient of Poisson distribution with mean e is
    (A) e (B) $\sqrt{e}$ (C) $\frac{1}{e}$ (D) $\frac{1}{\sqrt{e}}$

36. If X has Poisson with mean value 0.45, Y has Poisson with mean value 0.55 and X, Y are independent, then the conditional distribution of X/X + Y = 10 is
    (A) binomial with values of the parameters, 10 and 0.45
    (B) binomial with values of the parameters, 10 and 0.55
    (C) negative binomial with values of the parameters, 10 and 0.45
    (D) negative binomial with values of the parameters, 10 and 0.55

37. Which of the following distributions has lack of memory property ?
    (A) beta (B) exponential (C) gamma (D) Cauchy

38. In a family survey to be carried out among 600 families having exactly three children, what would be the expected number of families having all children males ?
    (A) 225 (B) 150 (C) 75 (D) 300

39. Suppose X has the standard Cauchy distribution. Let $Y = \frac{1}{2} + \frac{1}{\pi}\tan^{-1} X$. Then distribution of Y is
    (A) standard Cauchy (B) standard normal
    (C) uniform over (0, 1) (D) gamma

40. If 4^{th} central moment of a normal distribution is given as 12, what is its variance ?
    (A) 9 (B) 4 (C) 3 (D) 2

41. Distribution of the ratio of two independent standard normal variates is
    (A) Laplace (B) Lognormal (C) Exponential (D) Cauchy

42. Let X_1, X_2, X_3 be three independent standard normal variates. Then distribution of the statistic $\frac{\sqrt{2}X_3}{\sqrt{X_1^2 + X_2^2}}$ is

(A) Student's t with $\sqrt{2}$ d.f.

(B) Student's t with 2 d.f.

(C) Normal distribution with mean $\sqrt{2}$ and variance 3

(D) Normal distribution with mean 2 and variance 3

43. Which of the following relations among measures of central tendency of the lognormal distribution holds ?

(A) Mean < Median < Mode (B) Mean > Median > Mode

(C) Median < Mean < Mode (D) Median > Mean > Mode

44. Let X and Y be two iid random variables with absolutely continuous cdf F(.) and pdf f(.) . Then the pdf g(u) of U = max(X, Y), for $u \in R$, is

(A) 2 F(u) f(u) (B) 2 [1 – F(u)]f(u) (C) F(u) f(u) (D) [1 – F(u)]f(u)

45. If X_1, X_2, X_3, X_4, X_5 is a random sample from uniform (0, 1) distribution, then distribution of the sample median is

(A) Beta distribution of the first kind (B) Gamma distribution

(C) Beta distribution of the second kind (D) Cauchy distribution

46. If $X_1, X_2, \ldots, X_n$ is a random sample from a population with cdf F(x) and pdf f(x), then the conditional distribution of $X_{r:n}$ given $X_{s:n} = y$, where $1 \leq r < s \leq n$, is the same as the unconditional distribution of

(A) (s – r)th order statistic in a sample of size (n – r) from the cdf F(x) truncated left at y

(B) (s – r)th order statistic in a sample of size (n – r) from the cdf F(x) truncated right at y

(C) rth order statistic in a sample of size (s – 1) from the cdf F(x) truncated left at y

(D) rth order statistic in a sample of size (s – 1) from the cdf F(x) truncated right at y

47. Let (X, Y) have a bivariate normal with parameters $\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \rho$. Then variance of the conditional distribution of X given Y = y is

(A) $\rho^2 \sigma_2^2$ (B) $(1-\rho^2)\sigma_2^2$ (C) $(1-\rho^2)\sigma_1^2$ (D) $\rho^2 \sigma_1^2$

48. The values of the total correlation coefficients and the multiple correlation coefficient of a trivariate distribution are 0.86, 0.77, 0.72, 0.52. Among these, value of the multiple correlation coefficient is

(A) 0.86 (B) 0.52 (C) 0.72 (D) 0.77

49. If P(A) = 0.9 and P(B) = 0.8, then the minimum value of $P(A \cap B)$ is
(A) 0.9 (B) 0.8 (C) 0.7 (D) 0.98

50. What is the probability that atleast two of n persons in a room have the same birthday (ignoring the possibility of 29 February) ?

(A) $1 - \frac{364 \times 363 \times \ldots \times (365 - n + 1)}{(365)^{n-1}}$ (B) $\frac{364 \times 363 \times \ldots \times (365 - n + 1)}{(365)^{n-1}}$

(C) $1 - \frac{364 \times 363 \times \ldots \times (365 - n - 1)}{(365)^{n-1}}$ (D) $\frac{364 \times 363 \times \ldots \times (365 - n - 1)}{(365)^{n-1}}$

51. If A and B are events such that P(A) = 0 = P(B), then $P(A \cap B)$ equals
(A) 0 only when $A = \phi$ (B) 0 only when $B = \phi$
(C) 0 only when A and B are independent (D) 0

52. If X and Y are two random variables with the following bivariate distribution :

Y / X	Values of Y			Total Probability
	1	2	3	
Values of X				
0	0.10	0.20	0.25	0.55
1	0.10	0.15	0.20	0.45
Total Probability	0.20	0.35	0.45	1.00

Consider the following statements :
1) X and Y are uncorrelated
2) X and Y are independent
3) X and Y are not independent

Now state which of the above statement(s) is/are correct.
(A) 1 only (B) 2 only (C) Both 1 and 2 (D) 3 only

53. If A and B are independent events with P(A) = 0.3, P(B) = 0.4, then probability that 'A' occurs but B does not' is
(A) 0.18 (B) 0.28 (C) 0.82 (D) 0.72

54. A problem in Statistics is given to three students whose respective probabilities of solving it are 1/2, 1/3, 1/4. Then probability that the problem is solved equals

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) $\frac{3}{4}$ (D) 1

55. For the bivariate distribution defined in question no. 52 the conditional distribution of Y given X = 1 is given by

(A)

Values	1	2	3
Probability	10/45	15/45	20/45

(B)

Values	1	2	3
Probability	10/55	20/55	25/55

(C)

Values	1	2	3
Probability	0.20	0.35	0.45

(D) None of (A), (B) and (C)

56. Bayes' theorem is used for determining
(A) likelihoods
(B) prior probabilities
(C) posterior probabilities
(D) unconditional probabilities

57. If X is a non-negative integer valued random variable, then its expected value can be expressed as

(A) $\sum_{n=0}^{\infty} P(X \geq n)$
(B) $\sum_{n=0}^{\infty} P(X > n)$
(C) $\sum_{n=0}^{\infty} P(X \leq n)$
(D) $\sum_{n=0}^{\infty} P(X < n)$

58. Let $\phi(t)$ be a characteristic function and consider the following statements.

1) $|\phi(t)|^2$ is a characteristic function.
2) Real part of $\phi(t)$ is a characteristic function.

Which of the above statements is/are true ?

(A) 1 only
(B) 2 only
(C) both
(D) none

59. Let X_n, $n \geq 1$ and X be random variables defined on the same probability space. Which of the following relations among various types of convergence is/are true ?

(A) $X_n \xrightarrow{P} X \Rightarrow X_n \xrightarrow{d} X$

(B) $X_n \xrightarrow{r} X \Rightarrow X_n \xrightarrow{P} X$

(C) $X_n \xrightarrow{a.s.} X \Rightarrow X_n \xrightarrow{P} X$

(D) Relations in (A), (B) and (C)

60. Which of the following types of convergence is dealt by the strong law of large numbers ?

(A) convergence in probability (B) almost sure convergence
(C) convergence in mean (D) convergence in distribution

61. Name the version of the CLT given below :

If $\{X_n\}$ is a sequence of iid random variables with $E(X_1) = \mu$ and $V(X_1) = \sigma^2$, a finite constant and if $S_n = \sum_{k=1}^{n} X_k, n \geq 1$, then $\frac{S_n - n\mu}{\sqrt{n}\sigma} \xrightarrow{d} Z$, where $Z \sim N(0, 1)$

(A) Demoivre Laplace (B) Lindberg - Levy
(C) Lindberg-Feller (D) Liapunouv

62. Let $\{A_n\}$ be a sequence of sets. Then limit superior of the sequence is defined by

(A) $\bigcap_{n=1}^{\infty} \bigcup_{k=1}^{\infty} A_k$ (B) $\bigcap_{n=1}^{\infty} \bigcup_{k=n}^{\infty} A_k$
(C) $\bigcup_{n=1}^{\infty} \bigcap_{k=n}^{\infty} A_k$ (D) $\bigcup_{n=1}^{\infty} \bigcap_{k=1}^{\infty} A_k$

63. Consider the following statements :

1) Every σ-field is a monotone class.
2) Any monotone class, which is a field, is a σ-field.

Which of the above statements is/are true ?

(A) 1 only (B) 2 only (C) both 1 and 2 (D) none

64. Let $\{f_n\}$ be a sequence of measurable functions which is bounded below by an integrable function. Then which of the following inequalities holds good ?

(A) $\int \lim_{n \to \infty} \inf f_n d\mu \leq \lim_{n \to \infty} \inf \int f_n \, d\mu$ (B) $\int \lim_{n \to \infty} \sup f_n d\mu \geq \lim_{n \to \infty} \sup \int f_n d\mu$
(C) $\int \lim_{n \to \infty} \sup f_n d\mu \leq \lim_{n \to \infty} \sup \int f_n d\mu$ (D) $\int \lim_{n \to \infty} \inf f_n d\mu \geq \lim_{n \to \infty} \inf \int f_n d\mu$

65. Which of the following sequences does not converge to zero ?

(A) $\left\{\frac{1}{n}\right\}$ (B) $\left\{\frac{1}{n^2}\right\}$ (C) $\left\{\frac{1}{3^n}\right\}$ (D) $\{3^n\}$

66. The value of $\lim_{n \to \infty} (1 + 1/n)^n$ is

(A) 1 (B) e (C) $\frac{1}{e}$ (D) 0

67. The necessary and sufficient condition for convergence of a series $\sum a_n$ of positive real numbers is

(A) $\lim\limits_{n \to \infty} a_n = 0$

(B) the sequence $\{S_n\}$ of its partial sums is bounded above

(C) the sequence $\{S_n\}$ of its partial sums is bounded below

(D) $\lim\limits_{n \to \infty} a_n^{1/n} = 0$

68. At x = 0 the function, $f(x) = \begin{cases} \frac{|x|}{x}, & x \neq 0 \\ 1, & x = 0 \end{cases}$ is/has

(A) left continuous
(B) right continuous
(C) continuous
(D) discontinuity of the second kind

69. Which of the following vectors are linearly independent ?

(A) $U_1 = (1, 2), V_1 = (3, -5)$
(B) $U_2 = (1, -3), V_2 = (-2, 6)$
(C) $U_3 = (2, 4, -8), V_3 = (3, 6, -12)$
(D) $U_4 = (1/2, -3/2), V_4 = (1, -3)$

70. If U and W are finite dimensional subspaces of a vector space and dim (S) denotes the dimension of the space S, then dim (U + W) equals

(A) dim (U) + dim (W) + dim $(U \cap W)$
(B) dim (U) + dim (W) – dim$(U \cap W)$
(C) dim (U) + dim (W)
(D) dim (U) – dim (W)

71. Let $A = \begin{bmatrix} 2 & 0 \\ 3 & 5 \end{bmatrix}$. If A is expressed as P + Q, where P and Q are respectively symmetric and skew-symmetric matrices, then P is given by

(A) $\begin{bmatrix} 5 & 3/2 \\ 3/2 & 1 \end{bmatrix}$
(B) $\begin{bmatrix} 1 & 5/2 \\ 5/2 & 3 \end{bmatrix}$
(C) $\begin{bmatrix} 0 & -3/2 \\ 3/2 & 0 \end{bmatrix}$
(D) $\begin{bmatrix} 2 & 3/2 \\ 3/2 & 5 \end{bmatrix}$

72. Which of the following matrices is positive definite ?

(A) $\begin{bmatrix} 3 & 4 \\ 4 & 5 \end{bmatrix}$
(B) $\begin{bmatrix} 8 & -3 \\ -3 & 2 \end{bmatrix}$
(C) $\begin{bmatrix} 2 & 1 \\ 1 & -3 \end{bmatrix}$
(D) $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$

73. The eigen values of the matrix $\begin{bmatrix} 3 & -4 \\ 2 & -6 \end{bmatrix}$ are

(A) 2, –5
(B) –2, 5
(C) 1, –5/2
(D) –1, 5/2

74. The characteristic polynomial of the matrix, $\begin{bmatrix} 1 & 1 & 2 \\ 0 & 3 & 2 \\ 1 & 3 & 9 \end{bmatrix}$ is given by $t^3 - kt^2 + 31t - 17$. Then the value of k is

(A) –13 (B) 13 (C) –17 (D) 17

75. Let A and B be square matrices of order n, Then the minimum value of rank (AB) is given by

(A) rank (A) $\times$ rank (B)
(B) rank (A) + rank (B)
(C) rank (A) + rank (B) – n
(D) rank (A) + rank (B) + n

76. The algebraic multiplicity of the eigen value 2 of the matrix $\begin{bmatrix} 3 & -1 & 1 \\ 7 & -5 & 1 \\ 6 & -6 & 2 \end{bmatrix}$ is given to be 2. Which of the following numbers is the geometric multiplicity of 2 ?

(A) 4 (B) 3 (C) 1 (D) 5

77. Let z, z_1 and z_2 be any three complex numbers. Which of the following inequalities is not true ?

(A) $-|z| \le \text{Re } z \le |z|$
(B) $-|z| \le \text{Im } z \le |z|$
(C) $|z_1 - z_2| \le |z_1| + |z_2|$
(D) $|z_1 + z_2| \le |z_1| + |z_2|$

78. If a is a simple pole for $f(z) = \frac{g(z)}{z-a}$ where g(z) is analytic at a and $g(a) \neq 0$, then residue of f(z) at a is given by

(A) g (a) (B) $\frac{1}{g(a)}$ (C) $g'(a)$ (D) $\frac{1}{g'(a)}$

79. Order of the pole at z = 0 of the function $\frac{e^z}{z^3}$ is

(A) 1 (B) 2 (C) 3 (D) 4

80. The value of $\int_C \frac{e^z\,dz}{(z+2)(z-1)}$, where C is the circle $|z-1| = 1$, equals

(A) $\frac{2\pi ie}{3}$ (B) $\frac{3i}{2\pi e}$ (C) $\frac{2\pi i}{3}$ (D) $\frac{3i\pi}{2}$