

- 3) Sampling frame means
- A) Collection of all sampling units
 - B) List of all sampling units
 - C) Use of probability to select sample
 - D) None of these
- 4) A box consists of 30 balls. Out of these 30 balls, 5 Red balls are labeled as 1 to 5; 10 Green balls are labeled as 1 to 10 and 15 Yellow balls are labeled as 1 to 15. A ball is drawn at random from this box and its label is found to be a multiple of 3. What is the probability that it is of Green color?
- A) $1/3$
 - B) $1/14$
 - C) $2/7$
 - D) $1/2$
- 5) If $X_1, X_2, \dots, X_n$ is a random sample from $N(\mu, 1)$, then unbiased estimator of μ^2 is _____.
- A) $\frac{1}{n} \sum_{i=1}^n X_i^2$
 - B) $\frac{1}{n} \sum_{i=1}^n X_i^2 - 1$
 - C) $\frac{1}{n} \sum_{i=1}^n X_i^2 + 1$
 - D) $\frac{1}{n} \sum_{i=1}^n X_i$
- 6) Which of the following is a false statement?
- A) Unbiased estimators are not unique.
 - B) Sample mean is always an unbiased estimator of population mean if exists.
 - C) Sample mean square is always an unbiased estimator of population variance if exists.
 - D) Sample raw moments are always unbiased estimators of corresponding population raw moments.

- 7) T_n is a consistent estimator of θ if _____.
 A) T_n converges to θ with probability one
 B) $\lim_{n \rightarrow \infty} P(|T_n - \theta| > \epsilon) \rightarrow 0$
 C) $\lim_{n \rightarrow \infty} P(|T_n - \theta| < \epsilon) \rightarrow 1$
 D) All of above are true statements
- 8) If T_n is a consistent estimator of θ then under some regularity conditions, _____
 A) $\sqrt{T_n}$ is a consistent estimator of $\sqrt{\theta}$
 B) T_n^2 is a consistent estimator of θ^2
 C) $\text{Log}(T_n)$ is a consistent estimator of $\log(\theta)$
 D) All of above are true statements
- 9) If T_n is a sufficient estimator of θ , then $\frac{d \log L}{d\theta}$ is function of _____ only.
 A) T_n
 B) T_n and θ
 C) θ
 D) T_n , θ and $(X_1, X_2, \dots, X_n)$
- 10) Which of the following distributions does not belong to exponential family?
 A) Normal
 B) Pareto
 C) Poisson
 D) Binomial
- 11) A one-dimensional statistic whose distribution does not depend on the parameter is known as _____.
 A) Point Estimator
 B) Interval Estimator
 C) Ancillary statistic
 D) Sufficient statistic
- 12) Mean square error of an estimator T of a parameter θ is
 A) $E(T^2) - \theta^2$
 B) $E(T) - \theta$
 C) $E(T - \theta)^2$
 D) $E(T^2) + \theta^2$

- 13) If X and Y are two independent chi-square variates with m and n degrees of freedom, then distribution of $X/(X+Y)$ is
- A) F-distribution with (m, n) d.f.
 - B) Beta Ist kind with (m/2, n/2)
 - C) Beta IInd kind with (m, n)
 - D) χ^2 - distribution with m/n d.f
- 14) The Minimum Variance Bound Unbiased Estimator of the parameter μ of normal distribution based on sample $X_1, X_2, \dots, X_n$ is
- A) $\bar{X}$
 - B) $2\bar{X}$
 - C) $\bar{X}^2$
 - D) S^2
- 15) If a statistic T is sufficient for θ , then ____.
- A) T is unbiased for θ
 - B) T is sufficient for 2θ
 - C) T is consistent for θ
 - D) None of these
- 16) In factorial designs, if the difference between responses produced when the level of one factor is fixed while the levels of other factor change is significantly large, is indicative of presence of
- A) main effect
 - B) confounding
 - C) interaction
 - D) None of these alternatives is correct.
- 17) In a one-way ANOVA, if the observed value of the F test statistic is greater than the critical F value, you:
- A) reject H_0 because there is evidence that all the means differ
 - B) reject H_0 because there is evidence that atleast one of the means differs from the others
 - C) do not reject H_0 because there is no evidence of a difference in the means
 - D) do not reject H_0 because one mean is different from the others

- 18) A car rental company wants to select a computer software package for its reservation system. Three software packages (A, B, and C) are commercially available. The car rental company will choose the package that has the lowest mean number of renters for whom a car is not available at the time of pickup. An experiment is set up in which each package is used to make reservations for five randomly selected weeks. How should the data be analyzed?
- A) Chi-square test
 - B) One-way ANOVA F test
 - C) t test for the differences in means
 - D) Likelihood ratio test
- 19) A 2×2 factorial design
- A) is a one-way ANOVA.
 - B) results in four orthogonal treatment contrasts
 - C) contains significant interaction effects.
 - D) can be viewed as two-way ANOVA with interaction
- 20) For fast-food restaurants, the drive-through window is an increasing source of revenue. The chain that offers that fastest service is considered most likely to attract additional customers. In a study of 20 drive-through times (from menu board to departure) at 5 fast-food chains, the following ANOVA table was developed.

Source	DF	Sum of Squares	Mean Squares	F
Among Groups (Chains)		6,536	1,634.0	12.51
Within Groups (Chains)	95		130.6	
Total	99	18,943		

The degrees of freedom associated with the F statistics in the last column are :

- A) (5,95)
- B) (4,95)
- C) (4,99)
- D) (5,99)

- 21) Which of the following is correct?
- If there are no main effects, there can be no interactions.
 - Whenever interactions are found, there must be main effects.
 - Whenever main effects are found, there must be atleast one interaction.
 - When both interactions and main effects are found, the interactions are interpreted first.
- 22) How would an interaction be indicated in a graphical representation?
- as parallel lines
 - as intersecting lines
 - as overlapping lines
 - as diagonal lines
- 23) Which of the following is not a basic principle of experimental design?
- Randomization
 - Replication
 - Local Control
 - Normality of random errors
- 24) N observations on random variables X and Y give $\sum_{i=1}^N d_i^2 = 12$ (where d_i is the difference between the ranks of the i^{th} observations on X and Y , respectively) and Spearman's rank correlation coefficient between X and Y is 0.9. Then, N is _____
- 8
 - 9
 - 10
 - 11
- 25) The model (in usual notation) $Y_{ijk} = \mu + \alpha_i + \beta_j + \tau_k + \epsilon_{ijk}$, $i = 1, \dots, p$; $j = 1, 2, \dots, q$; $k = 1, 2, \dots, n_{ij}$ where atleast two of n_{ij} are distinct is a set up corresponding to _____
- RBD
 - Factorial experiment
 - LSD
 - None of these
- 26) The expected value of mean error sum of squares under CRD having v treatments is _____.
- $\left(\sum_{i=1}^v n_i \sigma_i^2\right) / v$
 - $\left(\sum_{i=1}^v n_i \sigma_i^2\right) / v + \sigma^2$
 - $\frac{\left(\sum_{i=1}^v n_i \sigma_i^2\right)}{v-1}$
 - σ^2

27) Which of the following is the variance of Z_i according to the EWMA charts, if the observations x_i are independent random variables with variance σ^2 ?

- A) $\sigma_{z_i}^2 = \sigma^2 \left(\frac{\lambda}{2-\lambda} \right) [1 + (1+\lambda)^{2i}]$ B) $\sigma_{z_i}^2 = \sigma^2 \left(\frac{\lambda}{2-\lambda} \right) [1 + (1-\lambda)^{2i}]$
- C) $\sigma_{z_i}^2 = \sigma^2 \left(\frac{\lambda}{2-\lambda} \right) [1 - (1-\lambda)^{2i}]$ D) $\sigma_{z_i}^2 = \sigma^2 \left(\frac{\lambda}{2+\lambda} \right) [1 - (1-\lambda)^{2i}]$

28) Who of the following introduced EWMA charts?

- A) Lucas (1990) B) Saccucci (1990)
- C) Roberts (1959) D) Crowder (1987a, 1989)

29) Which of the following GMA stands?

- A) Geometric Moved Average B) Geometric Moving Average
- C) Geometrically Moved Average D) Geocentric Moving Average

30) The exponential smoothing constant λ in EWMA chart satisfies _____.

- A) $0 > \lambda$ B) $1 < \lambda$
- C) $1 \leq \lambda$ D) $0 < \lambda \leq 1$

31) Which of the following is the starting value of the EWMA?

- A) zero
- B) process target mean
- C) process target variance
- D) process target standard deviation.

32) Which of the following is the alternate name for EWMA charts ?

- A) GMA charts B) AMA charts
C) EMA charts D) RMA charts

33) Which of the following is the correct expression for the EWMA?

- A) $Z_i = \lambda x_i + (1 - \lambda) Z_{i-1}$ B) $Z_i = \lambda x_i - (1 - \lambda) Z_{i-1}$
C) $Z_i = \lambda x_i + (1 - \lambda) Z_{i+1}$ D) $Z_i = \lambda x_i + (1 + \lambda) Z_{i-1}$

34) Which of the following is an ideal chart for individual measurements?

- A) p-chart
B) CUSUM chart
C) EWMA chart
D) X bar and R chart

35) If Fisher's price and quantity index numbers are 110 and 120, respectively, then the value index number is _____

- A) 115
B) 110
C) 120
D) 132

36) EWMA charts are better than Shewhart control charts in detecting the _____ process shifts.

- A) large B) medium
C) small D) every

37) Six Sigma is introduced by _____

- A) Bill Smith
B) Walter Shewhart
C) Jack Welch
D) Douglas Montgomery

38) Let $X_1, X_2, X_3, \dots, X_n$ be a random sample of size n taken from $N(\theta, 100)$ population. Then UMP test exists for $H_0 : \theta < \theta_0$ against

- A) $H_1 : \theta \neq \theta_0$
 B) $H_1 : \theta > \theta_0$
 C) $H_1 : \theta = \theta_0$
 D) Either $H_1 : \theta > \theta_0$ or $H_1 : \theta < \theta_0$

- 39) If $X_1, X_2, X_3, \dots, X_n$ is a random sample of size n taken from $P(\theta)$ population. Which of the following is a composite hypothesis?
- A) $H : \theta = 0.5$ B) $H : \theta = 0.65$
C) $H : \theta = 20.5$ D) none of the above
- 40) If Λ denotes the likelihood ratio test statistic, and p be The difference between the number of parameters under the null and the alternative hypothesis. Then under certain regularly conditions which of the following is the asymptotic distribution of $2\log\Lambda$?
- A) Chi square distribution with p df B) F distribution with $p-1$ df
C) Chi square distribution with $p-1$ df D) t-distribution with p df
- 41) Which of the following statistical tests applicable to paired data?
- A) t-test B) Sign test
C) Wilcoxon signed Ranks test D) All the above
- 42) Given that $P(4.4 \leq \mu \leq 15.7) = 0.90$, Which of the following is correct?
- A) The width of confidence interval is 11.3.
B) 4.4 and 15.7 are 90% confidence limits of μ .
C) Probability that μ lies in the interval (4.4, 15.7) is .90.
D) All (A) to (C) are true.
- 43) An interval estimate for the difference between two population means can be found based on _____.
A) Two paired samples from normal populations
B) Two independent samples from normal populations
C) Both (A) and (B)
D) Neither (A) nor (B).
- 44) If $X_1, X_2, \dots, X_n$ is a random sample from exponential with parameter θ then interval estimate of θ can be obtained by use of
A) Normal distribution B) t-distribution
C) Chi-square distribution D) F-distribution

- 45) Which of the following non-parametric test is not applicable for two independent samples?
- A) Run test
B) K-S test
C) Sign test
D) Median test
- 46) The distribution of the sum of two independent and identically distributed Poisson (2) random variables is _____.
- A) geometric (2)
B) binomial (.2,2)
C) negative binomial (2,.2)
D) Poisson (4)
- 47) A nonparametric equivalent of one way ANOVA is _____.
- A) Sign test
B) Run test
C) Mann-Whitney U test
D) Kruskal Wallis Test
- 48) Let $X_1, X_2, \dots, X_n$ be random sample of size n from exponential distribution with mean θ . Then the pivotal quantity for θ is _____.
- A) $\bar{X}$
B) $\frac{\bar{X}}{\theta}$
C) $\theta \bar{X}$
D) $\bar{X} - \theta$
- 49) If the PGF of random variable X is $P^X(s) = \sum_{x=-5}^5 \frac{|x|s^x}{30}$ then $V(X) =$ _____.
- A) 0
B) 15
C) 14
D) 30
- 50) Bivariate random variable (X, Y) has a joint probability mass (pmf) function $p_{X,Y}(x,y)$ such that, $p_{X,Y}(x,y) = |x - y|/8$ for $x, y = 1, 2, 3$. What is $P(|X - Y| = 0)$?
- A) 0.5
B) 0.7
C) 0.9
D) None of the above
- 51) The standard deviation of exponential distribution with rate parameter 8 is
- A) 0.425
B) 0.125
C) 0.225
D) 0.325

- 52)** Which of the following is added to those constraints of equality type?
- A) Slack Variable B) Surplus Variable
C) Surplus and artificial Variable D) Artificial variable
- 53)** Feasible region is the set of points which satisfy
- A) The objective functions
B) Majority of the given constraints
C) All the given constraints
D) Non-negativity restrictions
- 54)** Which of the following statements is true with respect to the optimal solution of Linear Programming problem (LPP)?
- A) At optimal solution all resources are completely used
B) Every LPP has an optimal solution
C) Optimal solution of an LPP always occurs at an extreme point of the feasible region
D) If an optimal solution exists, there will always be at least one at an extreme point of the feasible region
- 55)** If the value of the objective function ‘Z’ of a LPP increases or decreases indefinitely then such solution is called as _____.
- A) Extreme Solution B) Bounded solution
C) Unbounded solution D) Degenerate solution
- 56)** Which of the following methods is a method to obtain initial solution to a Transportation Problem?
- A) Simplex Method B) MODI Method
C) North-West Corner Method D) Hungarian Method

- 57) The joint probability density function (pdf) of (X, Y) is $f(x, y) = 2(x + y)$, $0 \leq x \leq y \leq 1$. Then, the marginal pdf of X is _____.
- A) $(2x + 1) / 2$, $0 \leq x \leq y$
B) $2x + 1$, $0 \leq x \leq 1$
C) $2x + 1$, $0 \leq x \leq y$
D) $1 + 2x - 3x^2$, $0 \leq x \leq 1$
- 58) The Penalty in Vogel's Approximation Method represents difference between _____ costs of respective row / column.
- A) Any two
B) Two Largest
C) Largest and smallest
D) Two smallest
- 59) The objective function for a L.P model is $Z=3X+2Y$, if $X=10$ and $Y = 30$. What is the value of the objective function?
- A) 5
B) 50
C) 90
D) 150
- 60) Number of basic allocations in any row or column in an Assignment Problem can be
- A) at least one
B) exactly one
C) at most one
D) two or more
- 61) Customer behavior in which the customer moves from one the queue to another in a multiple channel situation is called as
- A) balking
B) reneging
C) jockeying
D) alternating
- 62) Which of the following is not a key operating characteristic for a queuing system?
- A) utilization factor
B) percent idle time
C) average time spent waiting in the system and queue
D) none of these

- 63) How many minimal path sets are there for a parallel system with n components?
A) n B) 1
C) $n-1$ D) $2n$
- 64) For a series system of 2 identical components with each component having reliability equal to 0.5. the reliability of the system is ____
A) 0.50 B) 0.25
C) 0.75 D) 0.625
- 65) Which of the following distribution doesn't have ageing effect?
A) Normal B) Exponential
C) Lognormal D) Beta
- 66) Reliability of a system always lies between
A) $-\infty$ and ∞ B) -1 and 1
C) 0 and 1 D) 0 and ∞
- 67) Survival function of exponential distribution is _____.
A) Monotonic increasing B) Monotonic decreasing
C) Constant D) Monotonic non-decreasing
- 68) Two medicines have following statistics about their curing period of some disease :

Medicine	No. of Patients	Total of curing periods	S.D. of curing periods
M1	50	840	7
M2	60	600	5

Which medicine is consistent with respect to its disease curing period?

- A) Medicine M1
B) Medicine M2
C) Both, Medicine M1 and Medicine M2 are equally consistent
D) Neither Medicine M1 nor Medicine M2 is consistent

- 69) The number of minimal paths in 2 out of 3 system is _____.
A) 0
B) 1
C) 2
D) 3
- 70) If $X \sim U(-2, 2)$ then which of the following is the lower bound for $P(|X| < \sqrt{12})$
A) 0.5
B) 0.333
C) 1/9
D) 1/26
- 71) What does the “k” in Chebyshev’s theorem represent?
A) Standard deviation
B) Variance
C) Multiple of standard deviations distance from the mean
D) Multiple of standard deviations distance from the median
- 72) 400 books were selected at random from a library. If the mean length of books in this library is 300 pages with standard deviation of 50, what is the minimum number of books that must be between 200 and 400 pages?
A) 300
B) 75
C) 25
D) 350
- 73) A parallel system of three components works, if _____.
A) All three components work
B) At least one component works
C) At least two components work
D) None of these
- 74) The time series with annual value from 2000 to 2004 has a trend line $y = 5 + 9.2x$ and the trend value for 2002 is 5. Then the trend value for 2005 is _____.
A) 32.6
B) 41.8
C) 51.0
D) none of these

75) Which of the following is not an example of time series problem?

1. Estimating the gold price for tomorrow given the monthly prices for last sixty months for the same region.
2. Estimating the total sales of an insurance policy next year, given annual sales of another similar policy for last 50 years.
3. Estimating the average consumption of sugar in Kolhapur city per month, given the consumption of sugar for a specific month for 50 randomly selected families in Kolhapur.

- A) All 1,2,3
B) 1 and 2
C) 1 and 3
D) None of the 1, 2, 3

76) Which of the following statements is false in the context of hypotheses testing?

- A) Reject H_0 when H_0 is true is type I error.
B) $H_1 : \mu_1 \neq \mu_2$ is two tailed hypothesis.
C) $H_0 : |\mu| = 4.6$ is composite hypothesis.
D) p-value is same as the level of significance.

77) For a data set the regression equation is $E(Y) = 21 - 3X$. The correlation coefficient for this data

- A) must be 0 B) is negative
C) must be 1 D) is positive

78) The number of possible samples of size n from a population of N units in SRSWOR is _____.

- A) N^2
B) N^n
C) n^2
D) None of these

79) What is the range for Karl Pearson's Coefficient of Kurtosis β_2 , which is based on central moments?

- A) $-1 \leq \beta_2 \leq 0$ B) $0 \leq \beta_2 \leq 1$
C) $1 \leq \beta_2 \leq \infty$ D) $-\infty \leq \beta_2 \leq \infty$

- 80) If 'R' is correlation matrix of order 3 with elements r_{ij} , then a necessary and sufficient condition for coincidence of three regression plane is _____.
- A) $r_{12}^2 + r_{13}^2 + r_{23}^2 - 2r_{12}r_{13}r_{23} = -1$
 B) $r_{12}^2 + r_{13}^2 + r_{23}^2 + 2r_{12}r_{13}r_{23} = 1$
 C) $r_{12}^2 + r_{13}^2 + r_{23}^2 - 2r_{12}r_{13}r_{23} = 1$
 D) $r_{12}^2 + r_{13}^2 + r_{23}^2 + 2r_{12}r_{13}r_{23} = -1$
- 81) Let $X \sim U(0, 1)$, then the distribution of $\log \left(\frac{X}{1-X} \right)$ is ____.
- A) Normal
 B) Exponential
 C) Laplace
 D) Gamma
- 82) If X_1 and X_2 be a random sample of size two from exponential distribution with parameter λ , then the distribution of $X_1 + X_2$ would be :
- A) $U(0, 1)$
 B) $\text{Gamma}(2\lambda)$
 C) $\text{Exp}(2\lambda)$
 D) Is free from λ
- 83) Let X and Y be independent $N(-1, 1)$ variates. For non-zero constants a and b , $aX + bY$ follows ____.
- A) $N(-a - b, a^2 + b^2)$
 B) $N(a - b, a^2 + b^2)$
 C) $N(a - b, a^2 - b^2)$
 D) $N\left(a - b, \frac{a^2 + b^2}{2}\right)$
- 84) Let $X \sim \text{Cauchy}(0, 1)$, then $Y = 2/X$ follows ____.
- A) $\text{Cauchy}(0, 1)$
 B) $\text{Normal}(0, 1)$
 C) $\text{Laplace}(0, 1)$
 D) $\text{Cauchy}(0, 2)$
- 85) Let $X \sim \text{Exponential}(1)$ distribution, then the distribution of $Y = 1 - e^{-X}$ is
- A) $\text{Normal}(0, 1)$
 B) $\text{Laplace}(0, 1)$
 C) $\text{Uniform}(0, 1)$
 D) $\text{Exponential}(1)$

- 86)** The diagonal nature of variance-covariance matrix of Bivariate normal distribution implies that the underlying random variables are _____.
A) uncorrelated but not independent B) correlated
C) uncorrelated and independent D) dependent
- 87)** For which of the following distributions, MGF does not exist?
A) Normal B) Pareto
C) Lognormal D) Laplace
- 88)** Skewness of Exponential (λ) distribution is _____.
A) λ B) $1/\lambda$
C) $\sqrt{\lambda}$ D) 2
- 89)** Let X and Y are two normally distributed, random variables. Which of the following is true about the joint distribution of X and Y?
A) Must be Bivariate Normal B) Bivariate Exponential
C) Need not be Bivariate Normal D) Bivariate Cauchy
- 90)** Consider following statements :
(i) Mutually exclusive events are independent.
(ii) A standard normal distribution is platykurtic.
Then, _____.
A) Only (i) is true B) Only (ii) is true
C) Both are true D) Both are false
- 91)** Let X and Y be iid Exp(1) random variables, then what is the distribution of $Z = X - Y$?
A) Normal (0, 1) B) Exponential (1)
C) Laplace (0, 1) D) Uniform (0, 1)

- 92) The systematic sampling is more precise than simple random sampling if _____.
- A) The variance within the systematic sampling is less than the total variance in the population.
 - B) The variance within the systematic samples is more than the total variance in the population.
 - C) The variance between the systematic samples is less than the total variance in the population.
 - D) None of the above
- 93) Which of the following is not advantage of sampling?
- A) Reduces the sampling and non-sampling errors
 - B) It reduced the cost of survey
 - C) Some situations sampling is only way to study
 - D) It reduced the time of survey
- 94) In simple random sampling without replacement, which of the following is false?
- A) Every unit in the population has same chance of being selected in a sample.
 - B) $SE(\bar{y})$ is $\sqrt{\frac{N-n}{Nn}} S$, where $\bar{y}$ is sample mean and S^2 is population mean square
 - C) $\sqrt{\frac{N-n}{Nn}} S$ is not unbiased estimator of $SE(\bar{y})$, where $\bar{y}$ is sample mean and S^2 is sample mean square
 - D) None of the above
- 95) A population N is divided into k strata. A sample of size n is to be chosen and N_i is the size of the i^{th} stratum. Then sample size n as per proportional allocation is given by
- A) $n_i = n N$
 - B) $n_i / N_i = n / N$
 - C) $n_i N_i = n N$
 - D) none

- 96) For estimating the population mean T , let T_1 be the sample mean under SRSWOR and T_2 sample mean under SRSWR, then which relationship is true?
- A) $\text{Var}(T_1) < \text{Var}(T_2)$ B) $\text{Var}(T_1) > \text{Var}(T_2)$
 C) $\text{Var}(T_1) \leq \text{Var}(T_2)$ D) none
- 97) If the respondents do not provide the required information to the researcher, then it is
- A) non-sampling error B) the problem of non-response
 C) both A) and B) D) none
- 98) The sampling fraction in usual notation is expressed as
- A) n/N B) N/n
 C) $1-n/N$ D) None
- 99) Consider the statements :
- Statement I : Non-random sampling means all the units in the population have the same probability of selection.
- Statement II : In non-random sampling, units in the population are selected using lottery method.
- Then, ...
- A) Both statements I and II are true
 B) Only statement I is true
 C) Only statement II is true
 D) Neither statement I nor statement II is true
- 100) Let $\{25, 15, 23, 34, 12, 20, 37, 48, 36, 42, 18, 60\}$ be the population of size 12. Which of the following is not a systematic sample of size 3?
- A) 25, 12, 36 B) 15, 20, 42
 C) 23, 37, 60 D) 34, 48, 60



Rough Work