

1. Given the interval $I = [0,1]$ and a subset $A \subset I$. The function $f: A \rightarrow I$ is such that $f(A) = C$ where C is the Cantor set. Then which of the following is true?
- A) A is countable B) A is uncountable
 C) $A = I$ D) Such a function f does not exist

2. Let X and Y be two countable sets and consider the following statements:
 (i) $X \cap Y$ is countable, (ii) $X \cup Y$ is countable and
 (iii) The cartesian product $X \times Y$ is countable.

State which of the following is true?

- A) Only (i) is true
 B) Only (ii) is true
 C) (i) and (ii) are true but (iii) is not true
 D) (i), (ii) and (iii) are true
3. Suppose $\{S_n\}$ is a sequence, where $S_n = \frac{1}{n+1} + \frac{1}{n+2} + \dots + \frac{1}{n+n}$. Consider the following statements:
 (i) $\{S_n\}$ is monotone decreasing (ii) $\{S_n\}$ is monotone increasing
 (iii) $\{S_n\}$ is bounded above (iv) $\{S_n\}$ is neither monotone increasing nor monotone decreasing.

Now state which of the following is true?

- A) Only (i) and (iv) B) Only (ii) and (iv)
 C) Only (iii) and (iv) D) Only (ii) and (iii)
4. Suppose $\sum_{n=1}^{\infty} a_n$ is an absolutely convergent series of real numbers and $\{b_n\}$ is a bounded sequence of real numbers. Then
- A) $\sum_{n=1}^{\infty} a_n b_n$ is absolutely convergent
 B) $\sum_{n=1}^{\infty} b_n$ is absolutely convergent
 C) $\sum_{n=1}^{\infty} a_n b_n$ diverges
 D) $\sum_{n=1}^{\infty} a_n b_n$ need not be absolutely convergent

5. Consider the function $f(x) = |x|$, for $x \in \mathbb{R}$. Then
- A) f is not continuous at $x = 0$, but differentiable at $x = 0$
 B) f is continuous at $x = 0$, but not differentiable at $x = 0$
 C) f is both continuous and differentiable at $x = 0$
 D) f is neither continuous nor differentiable at $x = 0$

12. Suppose x_1, x_2, x_3 are the vectors of a basis set of \mathbb{R}^3 . Consider now the following linear combinations of x_1, x_2, x_3 :

$$y_1 = x_1 + x_2 + x_3$$

$$y_2 = x_1 - x_2 + x_3$$

$$y_3 = 2x_1 + x_2 - x_3$$

$$y_4 = x_1 - 4x_3$$

Then the dimension of the vector space generated by the vectors y_1, y_2, y_3, y_4 is equal to:

- A) 1 B) 2 C) 3 D) 4
13. The characteristic roots of an idempotent matrix are
 A) all 0 B) all 1
 C) zeros and ones D) all rationals
14. If A is a matrix of order $n \times n$ and $|A|$ is its determinant then which of the following is not true?
 A) $|A|$ is the product of the characteristic roots of A
 B) If A is non singular then all of its characteristic roots are non zeros
 C) The characteristic roots of a diagonal matrix are its diagonal elements
 D) The characteristic roots of an upper triangular matrix are different from the matrix obtained by replacing the elements above its diagonal elements by zeros

15. The value of 'a' for which the vectors $(1,3,-2), (2,5,0)$ and $(-3,a,-5)$ in \mathbb{R}^3 are linearly dependent is

- A) $\frac{5}{2}$ B) $-\frac{11}{4}$ C) $-\frac{25}{4}$ D) 0

16. In order that the matrix given by

$$A = \begin{pmatrix} 0 & 2m & n \\ \ell & m & -n \\ \ell & -m & n \end{pmatrix}$$

is orthogonal, the values of ℓ, m, n in order are given by

- A) $\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{6}}, \frac{1}{\sqrt{3}}$ B) $\frac{1}{2}, \frac{1}{2}, 1$
 C) $-1, 2, -1$ D) $-2, 1, 1$
17. If A and B are non-empty sets, then the $\liminf E_n = E$ and $\limsup E_n = F$ of the sequence of sets $\{E_n\}$ defined as $E_n = \begin{cases} A, & \text{if } n \text{ is odd} \\ B, & \text{if } n \text{ is even} \end{cases}$ are given by
 A) $E = A, F = B$ B) $E = A \cap B, F = A \cup B$
 C) $E = A \cup B, F = A \cup B$ D) $E = A \cap B, F = A \cap B$

18. Given E and F are two σ fields of subsets of the set X . Then which of the following is true?
- A) Both $E \cup F$ and $E \cap F$ are σ - fields
 B) Neither $E \cup F$ nor $E \cap F$ is a σ - field
 C) $E \cup F$ is a σ - field but $E \cap F$ is not a σ - field
 D) $E \cup F$ is not necessarily a σ - field but $E \cap F$ is a σ - field
19. Given B is the Borel field. Let F_1, F_2 and F_3 be the σ - fields generated by (i) the class of all open intervals of the type (a,b) (ii) the class of all half open intervals of the type $(a,b]$ and (iii) the class of all closed intervals of the $[a,b]$ of the real line R respectively. Then which of the following is true?
- A) $F_1 \subset F_2 \subset F_3 \subset B$ B) $B \subset F_1 \subset F_2 \subset F_3$
 C) $B \neq F_1 = F_2 = F_3$ D) $F_1 = F_2 = F_3 = B$
20. If μ is the Lebesgue measure and A is the set of all rationals in the interval $[-2, 2]$ then (A) is equal to
- A) 4 B) 2
 C) 0 D) A is not Lebesgue measurable
21. If the Stieltjes measure function $F(x)$ is defined by
- $$F(x) = \begin{cases} 0, & x < 0 \\ 1 - e^{-x}, & x \geq 0 \end{cases}$$
- and if $A = [-2, 2]$, then the Lebesgue – Stieltjes measure of A is equal to
- A) 4 B) $\frac{e^2 - 1}{e^2}$ C) $\frac{e - 1}{e}$ D) 2
22. The value of the integral $\int_0^2 |2x - 1| dx$ is equal to
- A) $\frac{5}{2}$ B) $\frac{1}{4}$ C) $\frac{9}{4}$ D) $\frac{3}{2}$
23. If A and B are events such that $P(A) = 1 = P(B)$, then $P(A \cap B)$ equals
- A) 1
 B) 1 only when A and B are independent events
 C) a positive real number less than 1
 D) a real number less than 1
24. Consider a random experiment with possible outcomes: a_1, a_2, \dots, a_N in which a_{j+1} is twice as likely as a_j for $j=1, 2, \dots, N-1$. Let $A = \{a_1, a_2, \dots, a_k\}$ for $k < N$. Then $P(A)$ is equal to:
- A) $\frac{k}{N}$ B) $\frac{2^k}{2^N}$ C) $\frac{k^2}{N^2}$ D) $\frac{2^k - 1}{2^N - 1}$

32. The probability density function of a bivariate random vector (X, Y) is given by

$$f(x, y) = \begin{cases} 2, & 0 < x < y < 1 \\ 0, & \text{otherwise.} \end{cases}$$

Then the marginal pdf of Y is given by

$$\begin{array}{ll} \text{A)} & f_2(y) = \begin{cases} 2 - 2y, & 0 < y < 1 \\ 0, & \text{otherwise.} \end{cases} \\ \text{B)} & f_2(y) = \begin{cases} 2y, & 0 < y < 1 \\ 0, & \text{otherwise.} \end{cases} \\ \text{C)} & f_2(y) = \begin{cases} 1, & 0 < y < 1 \\ 0, & \text{otherwise.} \end{cases} \\ \text{D)} & f_2(y) = \begin{cases} 3y^2, & 0 < y < 1 \\ 0, & \text{otherwise.} \end{cases} \end{array}$$

33. Let X be a non negative random variable with mean μ and standard deviation σ . Now for $c > 0$ consider the statements

$$\text{(i)} \quad P\{|X - \mu| \geq c\} \leq \frac{E[X - \mu]^r}{c^r}, r > 0 \quad \text{(ii)} \quad P\{|X - \mu| < c\sigma\} \geq 1 - \frac{1}{c^2}$$

Then state which of the following is correct?

$$\begin{array}{ll} \text{A)} & \text{(i) only is true} \\ \text{B)} & \text{(ii) only is true} \\ \text{C)} & \text{(i) and (ii) are both false} \\ \text{D)} & \text{Both (i) and (ii) are true} \end{array}$$

34. The random variable X has Poisson distribution with pmf $f(x) = \frac{e^{-\lambda} \lambda^x}{x!}$, $x = 0, 1, 2, \dots$. If $f(2) = 2f(0)$ is the case with $f(x)$, then the value of λ is equal to:

$$\text{A)} \quad 1 \qquad \text{B)} \quad 2 \qquad \text{C)} \quad 0.5 \qquad \text{D)} \quad 4$$

35. For a non-negative random variable X with continuous distribution it is observed that $P(X > x+y | x > y) = P(X > x)$ for $x, y \in \mathbb{R}^+$. Then the distribution of x is

$$\begin{array}{ll} \text{A)} & \text{Uniform} \\ \text{B)} & \text{Exponential} \\ \text{C)} & \text{Gamma} \\ \text{D)} & \text{Weibull} \end{array}$$

36. Suppose X is distributed as standard exponential distribution. Let Q^+ be the set of all positive rational numbers. Then $P(X \in Q^+)$ is equal to

$$\begin{array}{ll} \text{A)} & 1 \\ \text{B)} & \frac{1}{2} \\ \text{C)} & 0 \\ \text{D)} & \sum_{x \in Q^+} e^{-x} \end{array}$$

37. Suppose the mean deviation about the mean of a normal distribution is $\sqrt{2}$, then the standard deviation of the distribution is equal to:

$$\begin{array}{ll} \text{A)} & \sqrt{\frac{2}{\pi}} \\ \text{B)} & \sqrt{\frac{\pi}{2}} \\ \text{C)} & \sqrt{\pi} \\ \text{D)} & \frac{1}{\sqrt{2\pi}} \end{array}$$

38. If X and Y are two independent random variables with a common distribution which is negatively skewed, then the distribution of $X - Y$ is
 A) Negatively skewed B) Positively skewed
 C) Symmetric D) Uniform
39. Given X_1, X_2, X_3 are iid random variables with support R and it is known that $l_1 X_1 + l_2 X_2 + l_3 X_3$ is normally distributed for any arbitrary scalars l_1, l_2 and l_3 . Then the common distribution of X_1, X_2 and X_3 is
 A) Laplace B) Normal
 C) Exponential D) Cauchy
40. The pdf of standard normal variate X is denoted by $f(x)$ and its distribution function is denoted by $F(x)$. Then the distribution of $Y = F(X)$ is
 A) Uniform over $(0,1)$ B) Exponential
 C) Cauchy D) Gamma
41. Let X be a random variable with an absolutely continuous unimodal distribution. Consider the statements
 (i) Mean always exists (ii) Variance always exists
 (iii) Median always exists (iv) Mode always exists.
- Now state which of the above statements is/ are correct?
 A) (i) only B) (i) and (ii) only
 C) (iii) and (iv) only D) (ii) only
42. Given $X_{2:3}$ is the second order statistic of a random sample of size 3 drawn from a distribution with cdf $F(x)$. Then the cdf of $X_{2:3}$ is given by
 A) $F^2(x)$ B) $3 F^3(x) - 2 F^2(x)$
 C) $F(x) (1-F(x))$ D) $3F^2(x) - 2F^3(x)$
43. Given $X_{3:5}$ is the median of a random sample of size 5 drawn from a population with cdf $F(x)$ and pdf $f(x)$. Then the pdf of $X_{3:5}$ is
 A) $15 F^3(x) [1-F(x)]^2 f(x)$ B) $15[F(x)]^2 [1-F(x)]^3$
 C) $30[F(x)]^2 [1-F(x)]^2 f(x)$ D) $30F(x)[1-F(x)] f(x)$
44. Suppose $X_{r:n}$ is the r^{th} order statistic of a random sample of size n drawn from the standard exponential distribution. Then the mean $\mu_{r:n}$ and variance $\sigma^2_{r:n}$ of $X_{r:n}$ are
 A) $\mu_{r:n} = \sum_{i=r}^n \frac{1}{(n-i+1)}, \sigma^2_{r:n} = \sum_{i=r}^n \frac{1}{(n-i+1)^2}$
 B) $\mu_{r:n} = \sum_{i=1}^r \frac{1}{(n-i+1)}, \sigma^2_{r:n} = \sum_{i=1}^r \frac{1}{(n-i+1)^2}$
 C) $\mu_{r:n} = \frac{1}{n-r+1}, \sigma^2_{r:n} = \frac{1}{(n-r+1)^2}$
 D) $\mu_{r:n} = \frac{r}{n}, \sigma^2_{r:n} = \frac{r^2}{n(n-1)}$

45. If $X_{r:n}$ is the r^{th} order statistic of a random sample of size n drawn from the uniform distribution over $(0,1)$, then the distribution of $X_{r:n}$ is:
- Beta distribution of first kind
 - Beta distribution of second kind
 - Gamma distribution
 - t – distribution
46. Let X_1 and X_2 be two independent observations drawn from the exponential distribution with pdf $f(x) = \frac{1}{2} e^{-x/2}, x > 0$. Then the distribution of $X_1 + X_2$ is
- Exponential
 - Chi-square with 2 degrees of freedom
 - Chi-square with 4 degrees of freedom
 - Generalized exponential
47. Let X_1 and X_2 be two independent observations drawn from the exponential distribution with pdf $f(x) = \frac{1}{2} e^{-x/2}, x > 0$. Then the distribution of $Y = X_1/X_2$ is:
- F with (1,1) degrees of freedom
 - F with (2,2) degrees freedom
 - Student's t -distribution with 2 degrees of freedom
 - Student's t -distribution with 4 degrees of freedom
48. Given the random variable X follows student's t -distribution with one degree of freedom and the following statements:
- Mean of the distribution of X is zero
 - Median of the distribution of X is zero
- Now state which of the following is correct?
- (i) only
 - (ii) only
 - Both (i) and (ii)
 - Neither (i) nor (ii) is correct
49. Suppose (x_1, x_2, x_3) represent the outcomes of a biased coin in three successive tosses with x_i represents the outcome 1 for head turning up with probability p and 0 for tail turning up with probability $q = 1 - p$ in the i^{th} toss for $i = 1, 2, 3$. Let $T = x_1 + x_2 + x_3$ be a statistic. Then the equivalent classes E_0, E_1, E_2, E_3 determined by T as a partition in the sample space are given by:
- $E_0 = \{(0, 0, 0)\}, E_1 = \{(1, 0, 0), (0, 1, 0), (0, 0, 1)\}, E_2 = \{(1, 1, 0), (1, 0, 1), (0, 1, 1)\}, E_3 = \{(1, 1, 1)\}$
 - $E_0 = \{(0, 0, 0)\}, E_1 = \{(1, 0, 0), (1, 1, 0)\}, E_2 = \{(0, 1, 1), (1, 0, 1)\}, E_3 = \{(0, 0, 1), (0, 1, 0), (1, 1, 1)\}$
 - $E_0 = \{(0, 0, 0)\}, E_1 = \{(1, 0, 0), (0, 1, 0), (0, 0, 1)\}, E_2 = \{(1, 1, 0), (1, 0, 1)\}, E_3 = \{(0, 1, 1), (1, 1, 1)\}$
 - $E_0 = \{(0, 0, 0), (1, 1, 1)\}, E_1 = \{(1, 0, 0), (1, 0, 1)\}, E_2 = \{(0, 1, 0), (0, 0, 1)\}, E_3 = \{(1, 1, 0), (0, 1, 1)\}$

50. Let \bar{X} be the mean and m be the median of a random sample of size n drawn from the distribution with pdf $f(x, \theta) = \frac{1}{\pi} \frac{1}{1 + (x - \theta)^2}$, $-\infty < x < \infty$, $-\infty < \theta < \infty$. Consider

the following statements:

- (i) \bar{X} is unbiased for θ (ii) \bar{X} is a consistent estimator of θ
 (iii) m is a consistent estimator of θ .

Now state which of the above statements are correct?

- A) (i) only B) (ii) only
 C) Both (i) and (ii) D) (iii) only

51. Consider X_1, X_2, \dots, X_n as a random sample arising from $N(\theta, \theta^2)$, $\theta > 0$. Then a sufficient statistic for θ is

- A) $\sum_{i=1}^n X_i$ B) $\sum_{i=1}^n X_i^2$
 C) $\left(\sum_{i=1}^n X_i, \sum_{i=1}^n X_i^2 \right)$ D) $\sum_{i=1}^n (X_i - \bar{X})^2$

52. IF T is the UMVUE of θ and T' is any other unbiased estimator of θ with efficiency e , then the correlation coefficient between T and T' is equal to

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

53. If X_1, X_2, \dots, X_n is a random sample of size n drawn from $N(\mu, \sigma^2)$, then the UMVUE of σ^2 is

- A) $\frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X})^2$ B) $\frac{1}{n} \sum_{i=1}^n |X_i - \bar{X}|$
 C) $\frac{1}{n} \sum_{i=1}^n (X_i - \bar{X})^2$ D) $\frac{1}{n} T^2$ where $T = \frac{1}{n} \sum_{i=1}^n |X_i - \bar{X}|$

54. Let \bar{X} , M , m and R be the mean, median, mode and range of a random sample of size n drawn from the distribution with pdf $f(x, \theta) = \frac{1}{2} e^{-|x-\theta|}$, $-\infty < x < \infty$, $-\infty < \theta < \infty$. Then the MLE of θ is

- A) \bar{X} B) M
 C) m D) R

60. Given $Y = a_1 X_1 + a_2 X_2 + a_0$ is a multiple regression equation fitted based on the observations (Y_i, X_{1i}, X_{2i}) $i = 1, 2, \dots, 21$ of a data. Further it is given that $\sum_{i=1}^{21} (Y_i - \bar{Y})^2 = 540$ and $\sum_{i=1}^{21} (Y_i - \hat{Y}_i)^2 = 324$ where \hat{Y}_i is the estimated value of Y_i

by the regression. Now consider the following statements:

- (i) The degrees of freedom for the statistic to be used for testing $H_0: a_1 = a_2 = 0$ is (2,18)
(ii) The value of F-statistic to be used for testing H_0 is 6
(iii) The multiple correlation coefficient of Y on X_1 and X_2 is $\sqrt{\frac{2}{5}}$.

Now state which of the following is correct?

- A) (i), (ii) and (iii) B) (i) and (ii) only
C) (i) and (iii) only D) (ii) and (iii) only

61. In a tri-variate population with variables X_1, X_2, X_3 given that the simple correlation between any two variables is equal to $\frac{1}{2}$. Now consider the following statements:

- (i) $1 - R^2_{1,23} = \frac{2}{3}$, (ii) $r_{12,3} = \frac{1}{3}$, (iii) $R^2_{2,13} = \frac{2}{3}$.

Which of the above statements are correct?

- A) (i), (ii) and (iii) B) (i) and (ii)
C) (i) and (iii) D) (ii) and (iii)

62. Let (X_i, Y_i) , $i = 1, 2, \dots, n$ be observations recorded on units where X_i is the pre-treatment score and Y_i is the post-treatment score. Let \bar{X} and S_1 be the mean and standard deviation of the X_i -values, \bar{Y} and S_2 be the mean and standard deviation of Y_i -values. If \bar{d} and S_d are the mean and standard deviation of $d_i = Y_i - X_i$, $i = 1, 2, \dots, n$. Then to test H_0 : The treatment has no effect on the units, which of the following test statistic is used?

- A) $\frac{\bar{X} - \bar{Y}}{\sqrt{\frac{S_1^2 + S_2^2}{n-1}}}$ B) $\frac{\bar{X} - \bar{Y}}{\sqrt{[S_d^2 / (n-1)]}}$
C) $\frac{\bar{d}}{[S_d / \sqrt{n-1}]}$ D) $\frac{\bar{d}}{\sqrt{\frac{S_1^2 + S_2^2}{n-1}}}$

63. If two sample runs test is used to test H_0 : the two samples which are given below arises from the same population

Sample 1 : 1.3, 1.4, 1.4, 1.5, 1.7, 1.9, 1.9

Sample 2 : 1.6, 1.8, 2.0, 2.1, 2.1, 2.2, 2.3

then the number of runs to be used as a test statistic is:

- A) 6 B) 14 C) 5 D) 8

64. For a frequency distribution, normal distribution was fitted. The observed and expected frequencies in the various classes are given below

Class	1	2	3	4	5	6	7
Observed Frequency	5	8	15	20	19	16	7
Expected Frequency	4	12	18	22	18	12	4

Then to test for the goodness of fit using chi-square statistic what is the degrees of freedom of the statistic?

- A) 1 B) 2 C) 4 D) 6

65. The probability density function of the random variable X is given by

$$f(x) = \begin{cases} 3x^2, & 0 < x < 1 \\ 0, & \text{otherwise} \end{cases}$$

If 3 random numbers selected from the interval (0,1) are 0.125, 0.008, 0.216, then which of the following shall be considered as a random sample of size three from the above distribution?

- A) 0.125, 0.008, 0.216 B) 0.250, 0.016, 0.432
C) 0.375, 0.024, 0.648 D) 0.50, 0.20, 0.60

66. In order to draw a simple random sample of size 5 without replacement from a population of 30 units, the following two digit random numbers: 68, 44, 08, 97, 83, 12, 72, 56 are given. Then which of the following set of units shall be considered as the required sample?

- A) 08, 14, 08, 07, 23 B) 08, 14, 07, 23, 12
C) 08, 14, 07, 23, 26 D) 08, 14, 23, 12, 26

67. If srswr is used to draw a sample of three units from a population of N units, then the probability that the sample contains different units is

- A) $\frac{1}{N^3}$ B) $\frac{1}{NC_3}$
C) $\frac{3}{N^3}$ D) $\frac{(N-1)(N-2)}{N^2}$

68. If y_i, x_i represent the measurements made on the variates X and Y respectively on the i^{th} unit of a simple random sample of size n for $i = 1, 2, \dots, n$ and $R = \bar{Y} / \bar{X}$, then for large n, the variance of $\hat{R} = \bar{y} / \bar{x}$ is:

- A) $\sum_{i=1}^N \frac{(y_i - Rx_i)^2}{N-1}$ B) $\frac{N-n}{N(N-1)} \sum_{i=1}^N \frac{(y_i - Rx_i)^2}{n\bar{X}^2}$
C) $\sum_{i=1}^N \frac{(y_i - Rx_i)^2}{N\bar{X}^2}$ D) $\sum_{i=1}^N \frac{(y_i - Rx_i)^2}{(N-1)\bar{X}^2}$

69. In a survey, the aim is to estimate the population mean \bar{Y} such that the probability of large deviation of the sample mean \bar{y} with \bar{Y} exceeds d is equal to α . Assume \bar{y} is normally distributed and t as the abscissa of the normal curve that cuts off an area α at the tails. Then the sample size required for srs (for a population with mean square error S^2) is approximately equal to:
- A) $\frac{[(tS)/d]^2}{1 + N^{-1}[(tS)/d]^2}$ B) $\frac{1-\alpha}{\alpha} [(tS)/d]^2$
- C) $\frac{\alpha}{1-\alpha} [(tS)/d]^2$ D) $\alpha [(tS)/d]^2$
70. Which of the following set of units shall be considered as a systematic sample of size 6 drawn from a population of 43 units?
- A) 10, 16, 22, 28, 34, 40 B) 5, 11, 17, 23, 29, 35
- C) 15, 22, 29, 36, 43, 7 D) 6, 13, 20, 27, 34, 41, 7
71. If a population consists of a linear trend, then consider the following statements with regard to the removal of the effect of the trend:
- (i) Stratified sampling is more effective than the systematic sampling
(ii) Stratified sampling is more effective than simple random sampling
(iii) Systematic sampling is more effective than the simple random sampling
- Now which of the above statements are true?
- A) (i) and (ii) only B) (i) and (iii) only
- C) (ii) and (iii) only D) (i), (ii) and (iii)
72. If Y_1 and Y_2 are independent variates with common variance σ^2 and means given by $E(Y_1) = \theta_1 + \theta_2$, $E(Y_2) = \theta_2$, then consider the following statements
- (i) Every linear parametric function $\ell_1\theta_1 + \ell_2\theta_2$ is estimable
(ii) BLUE of θ_1 is $Y_1 - Y_2$
(iii) BLUE of θ_2 is Y_2
- Now state which of the above statements is/are true?
- A) (i) only B) (ii) and (iii) only
- C) (i) and (ii) only D) (i), (ii) and (iii)
73. Consider the Gauss-Markov setup $(Y, A\theta, \sigma^2 I_3)$, where $Y = (Y_1, Y_2, Y_3)'$
 $\theta = (\theta_1, \theta_2, \theta_3)'$, $A = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix}$ and I_3 is a unit matrix of order 3. Then among
 $b_1'\theta = \theta_1 - \theta_2 + \theta_3$, $b_2'\theta = \theta_1 + \theta_2 + \theta_3$, which of the following is true?
- A) $b_1'\theta$ is estimable but $b_2'\theta$ is not estimable
B) $b_1'\theta$ is not estimable but $b_2'\theta$ is estimable
C) Both $b_1'\theta$ and $b_2'\theta$ are not estimable
D) Both $b_1'\theta$ and $b_2'\theta$ are estimable

78. In a 2^3 -experiment with factors A, B and C, two interactions are completely confounded into the blocks and the principal block is obtained as $\{(1), abc\}$. Then the interactions confounded are
 A) A, BC, ABC B) B, BC, ABC
 C) C, AB, ABC D) AB, AC, BC
79. If the principal block of confounding in a 2^3 -experiment with factors A, B and C is $\{(1), abc\}$ and the same confounding system is repeated four times, then the degrees of freedom for error is
 A) 10 B) 12 C) 15 D) 16
80. In a 3^3 -experiment, the interactions ABC, ABC^2 , AB^2C and AB^2C^2 are partially confounded in different replications. Then in the analysis, the degrees of freedom for the error is equal to:
 A) 37 B) 71 C) 70 D) 78
