COMBINED TECHNICAL SERVICES EXAMINATION

(NON-INTERVIEW POST)

COMPUTER BASED TEST

DATE OF EXAM: 05.08.2025 AN

PAPER – II – STATISTICS AND MATHEMATICS

(PG DEGREE STANDARD) (CODE: 506)

1. If $v(x) = \lambda_1 + \lambda_3$, $v(y) = \lambda_2 + \lambda_3$ and $\text{cov}(x, y) = \lambda_3$ then the correlation between x and y of bivariate Poisson distribution is

(A) 0

(B) 1

(C) $\lambda_3 / [\lambda_1 + \lambda_3][\lambda_2 + \lambda_3]$

(D) $\dfrac{\lambda_3}{[(\lambda_1 + \lambda_3)(\lambda_2 + \lambda_3)]^{\frac{1}{2}}}$

(E) Answer not known

2. Let $\chi_1'^2$ and $\chi_2'^2$ be two independent non-central chi-square variates,

where $\chi_1'^2 \sim \chi'^2(K_1, \lambda_1)$ and

$\chi_2'^2 \sim \chi'^2(K_2, \lambda_2)$ then

$\chi_1'^2 + \chi_2'^2$ follows

(A) non-central chi-square distribution

(B) non-central t distribution

(C) non-central F distribution

(D) non-central beta distribution

(E) Answer not known

3. Which of the following statements are true about non-central t-distribution?

(i) When degrees of freedom K is large $(K \to \infty)$, the non-central t-distribution tends to standard normal distribution.

(ii) The mean of non-central t-distribution is $\frac{\sqrt{K}\left|\left(\frac{K-1}{2}\right)\delta\right.}{2^{\frac{1}{2}}\left|\frac{K}{2}\right.}$,

where $\delta = \frac{\mu}{\sigma}$.

(iii) If the non-centrality parameter of non-central distribution is not equal to zero then it becomes central t-distribution.

(A) (i) only
(B) (i) and (ii) only
(C) (i) and (iii) only
(D) (ii) and (iii) only
(E) Answer not known

4. Let $(X, Y) \sim$ Bivariate Poisson $(\lambda_1 + \lambda_3, \lambda_2 + \lambda_3, \lambda_3)$, the conditional distribution of X given $Y = y$ is the convolutions of

(A) Poisson and Binomial distribution
(B) Two Poisson distributions with parameter λ_1 and λ_2 respectively
(C) Two Binomial distribution with parameter $\frac{\lambda_3}{\lambda_2 + \lambda_3}$ and $\frac{\lambda_3}{\lambda_1 + \lambda_3}$ respectively
(D) Two Poisson distribution with parameter λ_1 and λ_3 respectively
(E) Answer not known

5. Which of the following are true about the assumptions of bivariate normal distribution?

I. The regression of Y on X is linear

II. The arrays are homoscedastic

III. The distribution of Y in different arrays is normal

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III
(E) Answer not known

6. Which of the following statement is true about Gamma distribution?

$$X \sim \gamma(\alpha, \lambda)$$

(i) Variance > mean if $\alpha < 1$

(ii) Variance = mean if $\alpha = 1$

(iii) Variance < mean if $\alpha > 1$

(A) (i) only
(B) Both (i) and (ii)
(C) Both (i) and (iii)
(D) (i), (ii) and (iii)
(E) Answer not known

7. If X follows beta distribution with parameter $m(>0)$ and 2 if $P\left(X \leq \frac{1}{2}\right) = \frac{1}{2}$ then the variance of X is

(A) $\frac{1}{10}$
(B) $\frac{1}{20}$
(C) $\frac{1}{25}$
(D) $\frac{1}{30}$
(E) Answer not known

8. Choose how many number of correct statements given below :

(1) If $X \sim N(\mu, \sigma^2)$, then $Z = \frac{X-\mu}{\sigma}$, is a standard normal variate with $E(Z)=0$ and $V(Z)=1$ and it is denoted by $Z \sim N(0,1)$.

(2) $\phi(-Z)=1-\phi(Z),\ Z>0$.

(3) $P(a \le X \le b)=\phi\left(\frac{b-\mu}{\sigma}\right)-\phi\left(\frac{a-\mu}{\sigma}\right)$.

(4) The graph of $f(x)$ is bell-shaped curve.

(A) (1) (B) (2)
(C) (3) (D) (4)
(E) Answer not known

9. Which of the following statement(s) is (are) correct/incorrect?

I. If x follows Beta distribution of second kind with parameters m and n then $\frac{1}{x}$ follows Beta distribution of first kind with parameters m and n.

II. If x and y are two independent Gamma variates with parameters m and n respectively then $\frac{x}{y}$ is a Beta distribution of second kind.

(A) I correct, II incorrect
(B) I incorrect, II correct
(C) Both I and II are correct
(D) Both I and II are incorrect
(E) Answer not known

10. If X and Y are independent random variables with probability mass functions $B(m, p)$ and $B(n, p)$ respectively. Then the conditional distribution of $X \mid X+Y$ is

(A) Geometric distribution

(B) Negative Binomial distribution

(C) Binomial distribution

(D) Hyper geometric distribution

(E) Answer not known

11. If a random variable $X \sim \beta_1(\mu, v)$ known as Beta variate of the first kind with parameters μ and V, then $1-X$ follows

(A) $\beta_1(1-\mu, 1-v)$

(B) $\beta_2(\mu, v)$

(C) $\beta_1(v, \mu)$

(D) $\beta_2(1-\mu, 1-v)$

(E) Answer not known

12. If s are iid $N(0, 1)$ Identify the distribution of $X_1 - X_2 + X_3 - X_4$

(A) $N(0, 1)$

(B) $N(4, 0)$

(C) $N(0, 2)$

(D) $N(0, 4)$

(E) Answer not known

13. When the population is finite and the sampling is done without replacement, which one of the following distribution is used?

(A) Gamma distribution

(B) Hyper geometric distribution

(C) Negative Binomial distribution

(D) Cauchy distribution

(E) Answer not known

14. The r^{th} factorial moment of hyper geometric distribution is

(A) $\frac{nM}{N}$

(B) $\frac{nM(N-M)(N-n)}{N^2(N-1)}$

(C) $\frac{M^{(r)}n^{(r)}}{N^{(r)}}$

(D) $\frac{M^{(r)}N^{(r)}}{(n)^r}$

(E) Answer not known

15. If x and y are independent random variables then $\text{cov}\left(x, x+\sqrt{3}y\right)$ is

(A) 0

(B) $V(x)$

(C) $V(y)$

(D) $E(xy)$

(E) Answer not known

16. Let $E|X_k|^3 = V_{3K}$ and $\sum_1^n V_{3K} = V_n$. Then as $n \to \infty$, _____ implies that $\mathcal{L}(S_n / S_n) \to N(0, 1)$.

(A) $V_n / S_n \to 0$

(B) $V_n^3 / S_n \to 0$

(C) $V_n^{\frac{1}{3}} / S_n \to 0$

(D) $V_n^2 / S_n \to 0$

(E) Answer not known

17. If $t_n \xrightarrow{P} \theta$ (parameter), then which one of the following is true?

(A) $t_n^2 \to \frac{1}{\theta^2}$

(B) $t_n^2 \xrightarrow{P} \theta$

(C) $t_n^2 \xrightarrow{P} \theta^2$

(D) $t_n \to \frac{1}{\theta}$

(E) Answer not known

18. Let $\{X_n\}$ be a sequence of random variables and let X be a random variable defined on a sample space. X_n converges in probability to X if for all $\epsilon > 0$,

(A) $\lim_{n\to\infty} P\left[|X_n - X| < \epsilon\right] = 1$

(B) $\lim_{n\to\infty} P\left[|X_n + X| < \epsilon\right] = 1$

(C) $\lim_{n\to\infty} P\left[|X_n - X| > \epsilon\right] = 1$

(D) $\lim_{n\to\infty} P\left[|X_n - X| < \epsilon\right] = 0$

(E) Answer not known

19. Let X have the pdf

$$f(x) = \begin{cases} \frac{1}{2}(x+1), & -1 < x < 1 \\ 0 & , \textit{elsewhere} \end{cases}$$

Then the mean value of X is given by

(A) $\frac{1}{3}$

(B) $\frac{2}{9}$

(C) $\frac{2}{3}$

(D) $\frac{1}{2}$

(E) Answer not known

20. If the sequence $\{X_n, n \geq 1\}$ of random variables convergence in probability to the random variable X then

(A) $X_n \xrightarrow{L} X$, as $n \to \infty$

(B) $X_n \xrightarrow{L} X$, as $n \to \infty$

(C) $X_n + Y_n \xrightarrow{L} X + Y$ as $n \to \infty$

(D) $X_n Y_n \xrightarrow{L} XY$ as $n \to \infty$

(E) Answer not known

21. (i) If $X_n \xrightarrow{p} X$ and $X_n \xrightarrow{p} Y$, then $X = Y$ a.s

(ii) If $X_n \xrightarrow{a.s} X$ and $X_n \xrightarrow{a.s} Y$, then $X = Y$ a.s

(iii) If $X_n \xrightarrow{r} X$ and $X_n \xrightarrow{r} Y$, then $X = Y$ a.s

Which of the above is correct?

(A) (ii) only

(B) (i) and (iii) only

(C) (ii) and (iii) only

(D) (i), (ii) and (iii)

(E) Answer not known

22. Which of the below is correct?

(i) From Joint p.d.f (p.m.f) of two random variables X and Y we can obtain marginal p.d.f.'s (p.m.f 's)

(ii) From marginal distributions of two jointly distributed random variables, we can't determine the joint distributions of these two random variables

(A) (i) only

(B) (ii) only

(C) both (i) and (ii)

(D) neither (i) nor (ii)

(E) Answer not known

23. If F is a distribution function of one dimensional random variable X then

(A) $0 \leq F(x) \leq 1$

(B) $F(x) \leq F(y)$ if $x < y$

(C) Both (A) and (B)

(D) $0 \leq F(x) < \infty$

(E) Answer not known

24. If X has the probability density function $f(x)=\frac{1}{4}e^{-|x|/2}, -\infty < x < \infty$. The value of $E\|X\|$ is

(A) 0
(B) 1
(C) 2
(D) 3
(E) Answer not known

25. The inequality $E|XY| \le E^{1/r}|X|^r \cdot E^{1/s}|Y|^s$ where $r>1$ and $r^{-1}+s^{-1}=1$ is called

(A) Cr inequality
(B) Chebychev's inequality
(C) Holder's inequality
(D) Schwarz's inequality
(E) Answer not known

26. Match the following with respect to natural conjugate priors :

	Sampling distribution		Posterior distribution
(a)	$G(V, \beta)$	1.	$B(\alpha+x, \beta+n-x)$
(b)	$b(n,p)$	2.	$B(\alpha+r, \beta+x)$
(c)	$p(\lambda)$	3.	$G(\alpha+v, \beta+x))$
(d)	$NB(r;p)$	4.	$G(\alpha+x, \beta+1)$

	(a)	(b)	(c)	(d)
(A)	3	4	1	2
(B)	3	1	4	2
(C)	3	4	2	1
(D)	4	3	2	1

(E) Answer not known

27. Let $x_1, x_2, \ldots x_n$ be the random sample of size n from $N(\mu, 1)$. $T = \Sigma \frac{X_i^2}{n}$ is an unbiased estimator of

(A) μ (B) μ^2

(C) $1+\mu^2$ (D) $2+\mu^2$

(E) Answer not known

28. Method of moments fail in which of the following distribution?

(A) Exponential (B) Normal

(C) Cauchy (D) Poisson

(E) Answer not known

29. Which of the following properties satisfied by maximum likelihood function?

(i) consistency

(ii) unbiasedness

(iii) most efficient

(iv) sufficient if any exists

(A) (i), (ii) and (iii)

(B) (i), (iii) and (iv)

(C) (i), (ii) and (iv)

(D) (i), (ii) (iii) and (iv)

(E) Answer not known

30. For estimating $f(x,a_0,a_1,...a_k)$ as a linear function of the parameters $a_0,a_1,...,a_k$, the x's being known given values, the least square estimators obtained as linear functions of the y's will be

(A) Biased estimators
(B) Efficient estimators
(C) Sufficient estimators
(D) MVU estimators
(E) Answer not known

31. Which of the following is true about likelihood ratio test?

(i) In likelihood ratio test, the probability of type I error is controlled by suitably choosing the cut off point λ_0

(ii) Under certain conditions, $-2\log_e \lambda$ has an asymptotic normal distribution

(iii) LR test is consistent always

(A) (i) only
(B) (i) and (ii) only
(C) (ii) and (iii) only
(D) (i) and (iii) only
(E) Answer not known

32. Identify the distribution which does not possess the MLR property

(A) Binomial distribution
(B) Uniform distribution
(C) Normal distribution
(D) Cauchy distribution
(E) Answer not known

33. What is the maximum number of runs possible in a sequence of length 6 using two symbols?

(A) 6 (B) 4

(C) 3 (D) 5

(E) Answer not known

34. Let X be a random variable having the normal distribution $N(0, \sigma^2)$, the S.P.R test for accepting H_1 for testing $H_0 : \sigma^2 = \sigma_0^2$ against $H_1 : \sigma^2 = \sigma_1^2 \left(\sigma_1^2 > \sigma_0^2\right)$ is

(A) $\Sigma x_i^{\,2} \leq \left\{\sigma_0^2\sigma_1^2\left[2\log\left(\frac{1-\beta}{\alpha}\right) + m\log\frac{\sigma_1^2}{\sigma_0}\right]\right\} / \left(\sigma_1^2 - \sigma_0^2\right)$

(B) $\Sigma x_i^2 \geq \left[m\log\frac{\sigma_1^2}{\sigma_0}\right] / \left(\sigma_1^2 - \sigma_0^2\right)$

(C) $\Sigma x_i^2 \geq \left\{\sigma_0^2\sigma_1^2\left[2\log\left(\frac{1-\beta}{\alpha}\right) + m\log\frac{\sigma_1^2}{\sigma_0}\right]\right\} / \sigma_1^2 - \sigma_0^2$

(D) $\Sigma x_i^2 \leq \sigma_0^2\sigma_1^2\left[2\log\left(\frac{1-\beta}{\alpha}\right) + m\log\frac{\sigma_1^2}{\sigma_0}\right]$

(E) Answer not known

35. If the sample size in Wald -Wolfowitz run test is large , the variance U is distributed with mean

(A) $\frac{2n_1n_2}{n_1+n_2}+1$ (B) $\frac{2n_1}{n_1+n_2}+1$

(C) $\frac{2n_1n_2}{n_1+n_2}$ (D) $\frac{2n_2}{n_1+n_2}+1$

(E) Answer not known

36. Let X be a random variable having the normal distribution $N(0, \sigma^2)$ for testing $H_0 : \sigma^2 = \sigma_0^2$ against $H_1 : \sigma^2 = \sigma_1^2 \left(\sigma_1^2 > \sigma_0^2\right)$ the SPR test is

(A) Accept H_0 if $\Sigma x_i^2 \geq \dfrac{\sigma_0^2 \sigma_1^2 \left\{\log \dfrac{\beta}{1-\alpha} + \log \dfrac{\sigma_1^2}{\sigma_0^2}\right\}}{\sigma_1^2 - \sigma_0^2}$

(B) Accept H_0 if $\Sigma x_i^2 \leq \dfrac{\sigma_0^2\ \sigma_1^2 \left\{2\log \dfrac{\beta}{1-\alpha} + m \log \dfrac{\sigma_1^2}{\sigma_0^2}\right\}}{\sigma_1^2 - \sigma_0^2}$

(C) Accept H_0 if $\Sigma x_i^2 \leq \dfrac{\sigma_0^2 \sigma_1^2 \left\{\log \dfrac{\beta}{1-\alpha} + \log \dfrac{\sigma_1^2}{\sigma_0^2}\right\}}{\sigma_1^2 - \sigma_0^2}$

(D) Accept H_0 if $\Sigma x_i^2 \geq \dfrac{\sigma_0^2 \sigma_1^2 \left\{2\log \dfrac{\beta}{1-\alpha} + m \log \dfrac{\sigma_1^2}{\sigma_0^2}\right\}}{\sigma_1^2 - \sigma_0^2}$

(E) Answer not known

37. For testing of randomness, we can use

(A) Mann-Whitney U test
(B) Sign test
(C) Run test
(D) Krustal -Wallis test
(E) Answer not known

38. The test which has advantage of doesn't require data grouping over a Chi-square test for goodness of fit is

(A) Sign test
(B) Run test
(C) Mann-Whitney U-test
(D) Kolmogrov-Smirnov-test
(E) Answer not known

39. The following are the reaction times (in milliseconds) for randomly selected subjects who took either Drug A or Drug B.

Drug A : 1.96 2.24 1.71 2.41 1.62 1.93

Drug B : 2.11 2.43 2.07 2.71 2.50 4.84 2.88

If wilcoxon rank-sum test is conducted then the sum of ranks for drug B is

(A) 25
(B) 66
(C) 28
(D) 53
(E) Answer not known

40. Which of the following statements are true about Sequential Probability Ratio Test (S.P.R.T)?

(i) If the S.P.R.T. of strength (α, β) and the boundary points (A, B) terminates with probability 1 then $A \leq (1-\beta)/\alpha$; $B \geq \beta/(1-\alpha)$

(ii) For any random variable n which takes the values $0,1,2,\ldots, E(n) = \sum_{m=1}^{\infty} P(n \geq m)$

(iii) The S.P.R.T terminates with probability zero both under H_0 and H_1.

(A) (i) only
(B) (i) and (ii) only
(C) (i) and (iii) only
(D) (ii) and (iii) only
(E) Answer not known

41. Assertion [A] : Median test makes the correct decision with little more assurance than does the sign test but not decisively as the t-test.

Reason [R] : Median test is sensitive to the differences in location but not to differences in shape

(A) [A] is true but [R] is false

(B) Both [A] and [R] are true and [R] is the correct explanation of [A]

(C) [A] is false, [R] is true

(D) Both [A] and [R] are true, but [R] is not the correct explanation of [A]

(E) Answer not known

42. In test of randomness, the number of runs U is a r.v with mean $\frac{n+2}{2}$ and variance

(A) $\frac{n}{4}\left(\frac{n-2}{n-1}\right)$

(B) $\frac{n}{2}\left(\frac{n-2}{n-1}\right)$

(C) $\frac{n}{2}\left(\frac{n-2}{n-4}\right)$

(D) $\frac{n}{4}\left(\frac{n-2}{n-4}\right)$

(E) Answer not known

43. Wilcoxon test takes into account _____ of the differences in ranks.

(A) Direction

(B) Differences

(C) (A) and (B)

(D) Neither (A) nor (B)

(E) Answer not known

44. In Mann Whitney U test $U =$ _____ if all the X_i's are larger than all the Y_j's and $U =$ _____ if all the X_i's are smaller than all the Y_j's

(A) m, n

(B) o, m

(C) mn, o

(D) o, mn

(E) Answer not known

45. In median test $H_0 : f_1(x) = f_2(x)$ of two independent samples, then test statistic follows

(A) Normal distribution

(B) F distribution

(C) Binomial distribution

(D) Chi square distribution

(E) Answer not known

46. In testing of Hypothesis, the test statistic of a sample statistic lies between -1.96 and 1.96 then,

(A) 95% confidence that the Null hypothesis is true

(B) 95% confidence that the Null hypothesis is false

(C) 99% confidence that the Null hypothesis is true

(D) 99% confidence that the Null hypothesis is false

(E) Answer not known

47. Let $x_1, x_2, ..., x_n$ be iid random variables from exponential family. A sufficient condition for the existence of UMP test for testing $H_0 : \theta \leq \theta_0$ against $H_1 : \theta > \theta_0$ is

(A) $\overline{X}$ is a sufficient statistics

(B) The test statistic has a constant variance

(C) The family has monotone likelihood property in statistics $T(x)$

(D) The power function is constant in θ

(E) Answer not known

48. For testing $H_0 : \theta = \theta_0$ against $H_1 : \theta = \theta_1$, if $p(x \in W / H_0) \leq \alpha$ and $p(x \in W / H_1) \geq p(x \in W_1 / H_1)$ where W is the critical region and α is the size of critical region then the test is called

(A) Best level α test

(B) Most powerful test

(C) Both (A) and (B)

(D) Neither (A) nor (B)

(E) Answer not known

49. In testing $H_0 : \theta = \theta_0$ against $H_1 : \theta = \theta_1$ and if $P(x \in W / H_0) = \int_w \lambda_0 dx = \alpha$ and $P(x \in W / H_1) \geq P(x \in W_1 / H_1)$ then it is

(A) Most powerful test
(B) Uniformly most powerful test
(C) Power of the test
(D) Critical region
(E) Answer not known

50. Assertion [A] : The maximum value of probability of Type I error of a Test is called the size of the test.

Reason [R] : If H is composite hypothesis, probability of Type I error is variable quantity.

(A) Both [A] and [R] are true, [R] explanation of [A]
(B) Both [A] and [R] are true, [R] does not explain [A]
(C) [A] is true but [R] is not true
(D) [A] is false but [R] is true
(E) Answer not known

51. Which of the following is an indication of existence of multicollinearity?

(i) Multiple R^2 is 77%

(ii) VIF exceeds 5 or 10

(iii) Significant regression coefficients

(A) (i) only

(B) Both (i) and (ii)

(C) (ii) only

(D) Both (ii) and (iii)

(E) Answer not known

52. In multicollinearity Diagnostics the condition indices of the $X'X$ matrix in Eigen system analysis are

(A) $K_j = \lambda_{\max}, \; j = 1,2,...p$

(B) $K_j = \frac{\lambda_{\max}}{\lambda_j}, \; j = 1,2,...p$

(C) $K_j = \lambda_j \, \lambda_{\max}, \; j = 1,2,...p$

(D) $K_j = \lambda_j + \lambda_{\max}, \; j = 1,2,...p$

(E) Answer not known

53. For the regression model $y = \beta_1 x_1 + \beta_2 x_2 + \epsilon$, the estimates of the regression coefficients are $\hat{\beta}_1 = \frac{r_{1y} - r_{12}\, r_{2y}}{\left(1 - r_{12}^2\right)}$, $\hat{\beta}_2 = \frac{r_{2y} - r_{12}\, r_{1y}}{\left(1 - r_{12}^2\right)}$. If there is strong multicollinearity between x_1 and x_2, then the correlation coefficient r_{12} will be

(A) Zero
(B) Unity
(C) Small
(D) Large
(E) Answer not known

54. If R_j^2 is the coefficient of multiple determination from the regression of x_j on the remaining $p-1$ regressor variables, then $\left(1 - R_j^2\right)^{-1}$ is called

(A) Inflation factor
(B) Mean inflation factor
(C) Variance inflation factor
(D) Correlation inflation factor
(E) Answer not known

55. The relationship between the predictor variables can be judged by examining a quantity is called

(A) R
(B) R^2
(C) variance inflation factor
(D) Covariance
(E) Answer not known

56. In regression model, with analysis of variance, then the relationship SST = SSR + SSE is known as

(A) Least square identity

(B) Fundamental analysis of variance identity

(C) Weighted least square

(D) Partial regression coefficients

(E) Answer not known

57. In simple linear regression, listing $H_0 : \beta_1 = 0$ against $H_1 : \beta_1 \neq 0$, the conclusion can be taken aided by

(A) F-test only

(B) t-test only

(C) Both F and t test

(D) Neither F test nor t-test

(E) Answer not known

58. Why is the multiple linear regression model $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + \in$ called linear model?

(A) Response variable y is linear

(B) Predictor variables x_i's are linear

(C) Parameters β_i's are linear

(D) Error value $\in$ is linear

(E) Answer not known

59. In a multiple regression model, if there are no linear relationship between the regressors, then they are said to be

(A) Dependent

(B) Independent

(C) Orthogonal

(D) Non-linear dependent

(E) Answer not known

60. Assertion [A] : To test the hypothesis $H_0 : \beta_1 = \beta_1^{(0)}$ the test statistics $T = \frac{\hat{\beta}_1 - \beta_1^{(0)}}{S_{y/x}} \times S_x \sqrt{n-1}$ and $H_0 : \beta_0 = \beta_0^{(0)}$ the test statistics $T = \frac{\hat{\beta}_0 - \beta_{(0)}^{(0)}}{S_{y/x}\sqrt{\frac{1}{n} + \frac{\bar{x}^2}{(n-1)s^2 x}}}$. Both test statistics have the same degrees of freedom $n-2$.

Reason [R] : $S^2{}_{y/x}$ is only the random component in the denominator of both the statistics which itself has $n-2$ degrees of freedom.

(A) [A] is true but [R] is false

(B) [A] is false but [R] is true

(C) Both [A] and [R] are true and [R] is the correct explanation of [A]

(D) Both [A] and [R] are true but [R] is not the correct explanation of [A]

(E) Answer not known

61. The ANOVA for significance of regression in multiple regression model, the residual degrees of freedom is

(A) k

(B) $n-k-1$

(C) $n-1$

(D) $k-1$

(E) Answer not known

62. Which of the following measure explained the proportion of variation by the regressor x?

(A) F-measure

(B) R

(C) R^2

(D) Sum of square residual

(E) Answer not known

63. For simple linear regression model, the unbiased estimator of σ^2 is

(A) $\sum_{i=1}^{n}(y_i-\hat{y}_i)^2/n$

(B) $\sum_{i=1}^{n}(y_i-\hat{y}_i)^2/(n-1)$

(C) $\sum_{i=1}^{n}(y_i-\hat{y}_i)^2/(n-2)$

(D) $\sum_{i=1}^{n}(y_i-\hat{y}_i)^2/(n-4)$

(E) Answer not known

64. The least square estimator of multiple linear regression model is

(A) $\hat{\beta}=(x'x)(x'y)$

(B) $\hat{\beta}=(x'x)^{-1}(x'y)$

(C) $\hat{\beta}=(xx')^{-1}(xy')$

(D) $\hat{\beta}=(xx')(xy')$

(E) Answer not known

65. The least square estimators of simple linear regression model, which of the following statement(s) is/are correct?

(a) $\hat{\beta}_0$ and $\hat{\beta}_1$ are unbiased estimators.

(b) The least square estimators have the maximum variance compared with all other unbiased estimators.

(A) (a) correct, (b) false

(B) (a) false, (b) correct

(C) Both (a) and (b) are correct

(D) Both (a) and (b) are false

(E) Answer not known

66. Choose the correct statements from the following :

(a) The generalized linear model, can be used when assumptions of normality and constant are not satisfied.

(b) The GLM is a unification of both linear and non linear regression models.

(c) In GLM the response variable distribution must only a member of the exponential family.

(d) The normal error linear model is just a special case of GLM.

(A) (a) only

(B) (a), (b) only

(C) (a), (b) and (c) only

(D) (a), (b), (c) and (d)

(E) Answer not known

67. Choose option that is not a component of a generalized linear model

(A) Random

(B) Link function

(C) Systematic

(D) Pearson χ^2 statistic

(E) Answer not known

68. The canonical link function of standard normal distribution for the generalized linear model is called as

(A) Identity link
(B) Logistic link
(C) Probit link
(D) Log link
(E) Answer not known

69. Which of the following statements are true about generalized linear models?

(i) It assumes that the distribution of the response variable is a member of exponential family of distribution.

(ii) GLM is to develop a linear model for an appropriate function of the expected value of the response variable.

(A) (i) only
(B) (ii) only
(C) (i) and (ii) are not correct
(D) Both (i) and (ii)
(E) Answer not known

70. In the case of logistic regression, the link function is defined as

(A) $\eta = \ln \frac{\pi}{1-\pi}$
(B) $\eta = \pi(1-\pi)$
(C) $\eta = \ln \pi (1-\pi)$
(D) $\eta = \frac{\pi}{1-\pi}$
(E) Answer not known

71. Which interaction is confounded in the following 2^3 design?

	Rep I		Rep II		Rep III	
Block	1	2	3	4	5	6
	abc	ab	abc	ab	abc	ab
	a	ac	a	ac	a	ac
	b	bc	b	bc	b	bc
	c	(1)	c	(1)	c	(1)

(A) ab
(B) ac
(C) abc
(D) bc
(E) Answer not known

72. The estimates of treatments in a youden square are _____ of the row-block effects

(A) Independent
(B) Not independent
(C) Either (A) or (B)
(D) Neither (A) nor (B)
(E) Answer not known

73. If the experimenters consistently pick the largest differences to compare they will inflate the _____ of the test.

(A) Type I error
(B) Type II error
(C) Both (A) and (B)
(D) Neither (A) nor (B)
(E) Answer not known

74. Efficiently of experimental design D_1, over design D_2 is denoted by E. If $E > 1$ then design D_1 is _____ efficient then design D_2.

(A) Less
(B) More
(C) Equal
(D) Not equal
(E) Answer not known

75. An investigator has to take more and more number of replications as the heterogeneity among experimental material

(i) Decreases
(ii) Increases
(iii) Remains the same
(A) (i) only
(B) (ii) only
(C) (i) and (ii) only
(D) (i) and (iii) only
(E) Answer not known

76. The effect totals of unconfounded effects are known as

(A) Block comparisons
(B) Inter block comparisons
(C) Intra block comparisons
(D) BIBD
(E) Answer not known

77. Which of the following is orthogonal contrast?

(A) $z_1 = \overline{y}_1 + \overline{y}_2$ and $z_2 = \overline{y}_1 + 2\overline{y}_2 + \overline{y}_3$

(B) $z_1 = \overline{y}_2 - \overline{y}_3$ and $z_2 = \overline{y}_1 - 2\overline{y}_2 + \overline{y}_3$

(C) $z_1 = \overline{y}_1 + \overline{y}_3$ and $z_2 = \overline{y}_1 - 2\overline{y}_2 + \overline{y}_3$

(D) $z_1 = \overline{y}_1 - \overline{y}_3$ and $z_2 = \overline{y}_1 - 2\overline{y}_2 + \overline{y}_3$

(E) Answer not known

78. If in a Latin square design, the column or a row is omitted, what is the resultant design called?

(A) Incomplete block design

(B) Youden square design

(C) Graeco Latin square design

(D) Quasi-factorial design

(E) Answer not known

79. Identify the number of statements, which is correct corresponding to the necessary condition for the existence of a BIBD?

(i) $vr = bk$

(ii) $\lambda(v-1) = r(k-1)$

(iii) $b \leq v$

(iv) $v(\lambda-1) = r(k-1)$

(A) 4

(B) 3

(C) 2

(D) 1

(E) Answer not known

80. Identify the mutually orthogonal constraint.

(A) $y_1+y_2-y_3-y_4,\ y_1-y_2-y_3+y_4,\ y_1-y_2+y_3-y_4$

(B) $y_1+y_2-y_3-y_4,\ y_1-y_2-y_3+y_4,\ y_1+y_2+y_3-y_4$

(C) $y_1+y_2-y_3-y_4,\ y_1+y_2-y_3+y_4,\ y_1+y_2+y_3-y_4$

(D) $y_1+y_2-y_3-y_4,\ y_1+y_2-y_3+y_4,\ y_1-y_2+y_3-y_4$

(E) Answer not known

81. In a 3^2-factorial experiment with r replications the standard error for a mean level of factors A and B is

(A) $\dfrac{[\text{Error Mean sum of square}]^2}{3r}$

(B) $\sqrt{\dfrac{\text{Error mean sum of square}}{3r}}$

(C) $\dfrac{\text{Error mean sum of square}}{3^2 r}$

(D) [Error Mean Sum of square] $3r$

(E) Answer not known

82. In BIBD the matrix $N = \begin{bmatrix} n_{11} & n_{12}.....n_{1b} \\ n_{21} & n_{22}.....n_{2b} \\ \vdots & \vdots \\ n_{v1} & n_{v2}.....n_{vb} \end{bmatrix}$ is called _____

(A) Row matrix

(B) Column matrix

(C) Incidence matrix

(D) Square matrix

(E) Answer not known

83. What is the distribution of the sum of squares due to a set of mutually orthogonal contrasts?

(A) F

(B) $\sigma^2\chi^2$

(C) t

(D) non-central χ^2

(E) Answer not known

84. If $\bar{x}_1$ and $\bar{x}_2$ are the mean effects of two treatments replicated r_1 and r_2 times and r_1 and r_2 is equal then the standard error of $(\bar{x}_1 - \bar{x}_2)$ is

(A) $\sigma\sqrt{2/r}$

(B) $\sigma\sqrt{\dfrac{2}{r_1 + r_2}}$

(C) $\sigma\sqrt{\dfrac{1}{r_1} + \dfrac{1}{r_2}}$

(D) $\sigma/\sqrt{2r}$

(E) Answer not known

85. In two-stage sampling equal first stage units, the cost function $c = 4n + mn$ and $c = 100$, the optimum value of m is

(A) $\sqrt{\dfrac{s_w^{\,2}}{s_b^2 - s_w^{\,2}/m}}$

(B) $\sqrt[3]{\dfrac{s_w^{\,2}}{s_b^{\,2} - s_w^{\,2}/m}}$

(C) $\sqrt{\dfrac{s_w^{\,2} - s_b^{\,2}}{s_{b^2}}}$

(D) $2\sqrt{\dfrac{s_w^{\,2}}{s_b^2 - \dfrac{s_w^{\,2}}{m}}}$

(E) Answer not known

86. If p is the population correlation coefficient between y and x then the minimum variance of linear regression estimate is

(A) $V_{\min}(\bar{y}_{lr}) = \left(\dfrac{1-f}{n}\right)(1-p^2)$

(B) $V_{\min}(\bar{y}_{lr}) = (1-p^2)$

(C) $V_{\min}(\bar{y}_{lr}) = \left(\dfrac{1-f}{n-1}\right)(1-p^2)$

(D) $V_{\min}(\bar{y}_{lr}) = \left(\dfrac{1-f}{n}\right) s_y^2(1-p^2)$

(E) Answer not known

87. If the study variate (y) is approximately a constant and a multiple of the auxillary variable, then an estimator which is used to estimate the population mean or total by fitting a linear regression is called as

(A) Ratio estimator
(B) Regression estimator
(C) Biased estimator
(D) Consistent estimator
(E) Answer not known

88. The efficiency of cluster sampling increases as the factor _____ increases with cluster size.

(A) ρ
(B) $M\rho$
(C) $(M-1)\rho$
(D) $1/M$
(E) Answer not known

89. In two stage sampling, if the simple random sampling without replacement, the estimator of population mean and variance are _____ and _____ respectively.

(A) unbiased, biased
(B) biased, unbiased
(C) biased, consistent
(D) unbiased, unbiased
(E) Answer not known

90. In large samples, with simple random sampling, the ratio estimate $\hat{Y}_R$ has a smaller variance than the estimate $\hat{Y} = N\bar{y}$ if the value of ρ is

(A) $< \frac{1}{2}\left(\frac{S_x}{\bar{X}}\right) \Big/ \left(\frac{S_y}{\bar{Y}}\right)$

(B) $> \frac{1}{2}\left(\frac{S_x}{\bar{X}}\right) \Big/ \left(\frac{S_y}{\bar{Y}}\right)$

(C) $> \left(\frac{S_x}{\bar{X}}\right)\left(\frac{S_y}{\bar{Y}}\right)$

(D) $< \left(\frac{S_x}{\bar{X}}\right)\left(\frac{S_y}{\bar{Y}}\right)$

(E) Answer not known

91. Which of the following statement is incorrect?

(A) In cluster sampling, the sampling variance decreases with increasing number of clusters

(B) Sampling efficiency is likely to decrease with increase in cluster size

(C) Operationally more convenient than direct sampling

(D) It is more expensive than direct sampling

(E) Answer not known

92. The value of coefficients of variation of x and y are the same, the ratio estimator is superior if the value of p

(A) exceeds 0

(B) exceeds 0.1

(C) exceeds –0.5

(D) exceeds 0.5

(E) Answer not known

93. The variance of Ratio estimator is $V(\hat{Y}_R) =$

(A) $(1-f)\ (c_{yy} + c_{xx} - 2\ c_{yx})$

(B) $\frac{(1-f)}{n} Y^2(C_{yy} + C_{xx} - 2C_{yx})$

(C) $n(1+f)\ (c_{yy} - 2c_{yx})$

(D) $n(1-f)\ (c_{yy} + c_{xx} - 2c_{yx})$

(E) Answer not known

94. Assertion [A] : As the sample size increases, the non-sampling error tends to increase.

Reason [R] : The sample size increases, the behaviour of non-sampling error is likely to be opposite to that of sampling error.

(A) [A] is true but [R] is false

(B) [A] is false but [R] is true

(C) Both [A] and [R] are true and [R] is the correct explanation of [A]

(D) Both [A] and [R] are true but [R] is not the correct explanation of [A]

(E) Answer not known

95. The errors arising at the stages of ascertainment (responses or observations) and processing of data are termed as

(A) Sampling errors

(B) Non-sampling errors

(C) Type I error

(D) Type II error

(E) Answer not known

96. Which one of following is true about ATI of double sampling plan?

$$ATI = n_1 Pa_1 + (n_1 + n_2)Pa_2 + N(1 - Pa)$$

(i) Only n_1 items will be inspected if the lot is rejected on the basis of first sample.

(ii) $(n_1 + n_2)$ items will be inspected if the lot is accepted on the basis of second sample.

(iii) The entire lot of N items will be inspected if the lot is rejected

(A) (i) only
(B) (ii) only
(C) (i) and (ii) only
(D) (ii) and (iii) only
(E) Answer not known

97. Which one of the following is true about the AOQL of single sampling plan?

(i) If the sample contains more than c defectives $x > c$, there will be no defectives left in a lot size N.

(ii) If $x \leq c$, the number of defectives in a lot size N is $Np - x$.

(iii) If $0 \leq x \leq c$, the number of defectives is $N - x$.

(A) (i) only
(B) (ii) only
(C) (i) and (ii) only
(D) (ii) and (iii) only
(E) Answer not known

98. With usual notations, for rectifying inspection single sampling plan calling for 100 % inspection of the rejected lots, the AOQ values are calculated by

(A) $\frac{P(N-n)Pa}{n}$

(B) $\frac{P(n-N)Pa}{N}$

(C) $\frac{P(N-n)Pa}{N}$

(D) $\frac{P(N-Pa)n}{N}$

(E) Answer not known

99. According to Dodge and Romig the probability of accepting a lot with fraction defective is

(A) 100%
(B) 10%
(C) 95%
(D) 98%
(E) Answer not known

100. In single sampling, the size of the sample inspected from the lot is

(A) One
(B) Always constant
(C) Depend on AOQL
(D) Zero
(E) Answer not known

101. If $N = 10000$, $n = 89$, $c = 2$, $p = 0.01$ and $Pa = 0.9397$, what is the value of AOQ?

(A) 0.90 %
(B) 0.93 %
(C) 0.95 %
(D) 0.99 %
(E) Answer not known

102. In which sampling plan the chance of cent-per-cent inspection increases as the percentage of defectives in the lot increases?

(A) Single sampling plan
(B) Double sampling plan
(C) Acceptance sampling plan
(D) Multiple sampling plan
(E) Answer not known

103. If the defective pieces found are not repaired or replaced then the modified AOQ is

(A) $p\,Pa$
(B) $p\,(N - n)\,Pa$
(C) $[p\,(N - n)\,Pa]/[N - p\,[n\,Pa + N\,(1 - Pa)]]$
(D) $[p\,(N - n)\,Pa]/[n\,Pa + N\,(1 - Pa)]$
(E) Answer not known

104. Acceptance sampling is not used when

(A) The test is destructive
(B) The cost of 100% inspection is quite high
(C) The supplier's process capability is extremely good
(D) Although the suppliers process is satisfactory, the process needs continuous monitoring
(E) Answer not known

105. Assertion [A] : Homogenity of two successive estimates of the variance for random component V cannot be tested by variance ratio test.

Reason [R] : The consecutive terms V_k and V_{k+1} are not independent.

(A) [A] is true but [R] is false

(B) Both [A] and [R] are true; and [R] is the correct explanation of [A]

(C) [A] is false, [R] is true

(D) Both [A] and [R] are true, but [R] is not the correct explanation of [A] is correct

(E) Answer not known

106. A series showing non-stationarity in level such as can be represented by the model

(A) $\phi(B)\nabla z_t = \theta(B)a_t$

(B) $\phi(B)\nabla^2 z_t = \theta(B)a_t$

(C) $\nabla^2 z_t = \theta(B)$

(D) $\phi(B)\nabla^2 z_t = \theta(B)$

(E) Answer not known

107. If a time series consists of uncorrelated normal observations and has constant variance, it is called

(A) Gaussian white noise

(B) Normal stationary series

(C) Gaussian stationary series

(D) Normal white noise

(E) Answer not known

108. Which of the following statements are true about secular trend?

(i) A time series data may show upward trend or downward trend for a period of years

(ii) Variations are recurrent upward or downward movements in a time series but the period of cycle is greater than a year

(iii) Occurrence of unforeseen events like floods, earthquakes

(A) (i) only
(B) (i) and (iii) only
(C) (i) and (ii) only
(D) (ii) and (iii) only
(E) Answer not known

109. In ordinary regression ε_i is independent of y_j for all i and j. But in an auto-regressive series y_j and ε_i are independent if

(A) $i > j$
(B) $i < j$
(C) $i \neq j$
(D) $i = j = 0$
(E) Answer not known

110. The most widely-used test for stationarity is

(A) Dickey-Fuller test
(B) Shapiro test
(C) Box-pierce test
(D) Wilks-lambda test
(E) Answer not known

111. Which of the following argument is used to remove missing values in R?

(A) na
(B) na.rm
(C) mi.rm
(D) rm.mi
(E) Answer not known

112. Which of the following option is used for R-language to specify the color for x-axis and y-axis?

(A) col
(B) col.lab
(C) col.axis
(D) col.main
(E) Answer not known

113. Which one of the following function is used to importing a data into R-software?

(A) read.table ( )
(B) write.table ( )
(C) read.csv ( )
(D) import.table ( )
(E) Answer not known

114. Choose the R command to draw axes labeled x and y, the horizontal axis range from – 3 to 3, the vertical axis range from – 1 to 5 and the argument type = n.

(A) > plot (C (–3, 3), C (–1, 5), type = "n", xlab = "x", ytab = "y")
(B) > draw (C (–3, 3), C (–1, 5), type = "n", xaxis = "x", yaxis = "y")
(C) > Barplot (C (–3, 3), C (–1, 5), type = "n", xaxis = "x", yaxis = "y")
(D) > pic (C (–3, 3), C (–1, 5), type = "n", xlab = "x", ytab = "y")
(E) Answer not known

115. Identify the python programme which stores and retrieves a variable correctly?

(a) print ("Total =", total)
total = 6

(b) total = 6
print ("Total =", total)

(c) Print ("Total =", total)

(d) Print ("Total = 6")

(A) (a) (B) (b)

(C) (c) (D) (d)

(E) Answer not known

116. In python to find the inverse of a matrix in numpy, which of the following is used?

(A) numpy.inv(m) (B) numpy.linalg.inv(m)

(C) linalg.inv(m) (D) inv.inv(m)

(E) Answer not known

117. In python, what will be the output?

>>> c = 10

>>> c + = 5

>>> c – = 2

>>> c * = 3

>>> c

(A) 15 (B) 13

(C) 39 (D) 10

(E) Answer not known

118. Which of the following is a mutable data type?

(A) numbers
(B) str
(C) tuple
(D) dict
(E) Answer not known

119. ———— is a technique for ensuring that the results uncovered in an analysis are generalizable to an independent, unseen, data set.

(A) Data set partitioning
(B) Graphical evaluation
(C) Cross-validation
(D) Reclassification
(E) Answer not known

120. The decision trees produced by CART contain exactly ———— branches for each decision node.

(A) Three
(B) Two
(C) Four
(D) Eight
(E) Answer not known

121. If L is a finite extension of F and K is a sub field of L which contains F, then

(i) $[L:F] \mid [L:K]$

(ii) $[L:K] \mid [L:F]$

(iii) $[K:F] \mid [L:F]$

(A) (i) only
(B) (ii) only
(C) Both (ii) and (iii)
(D) Both (i) and (iii)
(E) Answer not known

122. If R is a unique factorization domain, then the _____ of two primitive polynomials in $R[x]$ is again a primitive polynomial in $R[x]$.

(A) Sum
(B) Difference
(C) Division
(D) Product
(E) Answer not known

123. Eisenstein's criterion for irreducibility applies to which of the following polynomials over Q?

(i) $x^3 + 3x^2 + 3x + 1$

(ii) $x^4 + 4x^3 + 6x^2 + 4x + 1$

(iii) $x^3 + 2x + 4$

(iv) $x^3 + 5x^2 + 10x + 15$

(A) (i) and (ii) only
(B) (ii) and (iii) only
(C) (i) only
(D) (iv) only
(E) Answer not known

124. The element $a \in K$ is said to be algebraic of degree 4 over F if it satisfies a non zero polynomial over F of degree

(A) 2

(B) 3

(C) 1

(D) 4

(E) Answer not known

125. Wedderburn's theorem states that a finite _____ is necessarily a _____

(A) Commutative ring, field

(B) Commutative ring, commutative field

(C) Division ring, field

(D) Division ring, commutative field

(E) Answer not known

126. The number of p-sylow subgroups in G, for a given prime, is of the form

(A) $1+kp$

(B) p^a

(C) $kp+3$

(D) kp

(E) Answer not known

127. Let $O(G)=11^2.13^2$. Then identify the correct statements.

(1) G has only one 11-sylow subgroup of order 11^2

(2) G has only one 13-sylow sub group of order 13^2

(3) G is abelian

(A) (1) and (3) only

(B) (1) and (2) only

(C) (1), (2) and (3)

(D) (2) and (3) only

(E) Answer not known

128. Let G be a group, p be any p-sylow subgroup of G, then $O(G)/O(N(P))$ equals

(A) $1-kp$

(B) The number of p-sylow subgroups in G

(C) The number of multiples of $O(G)$

(D) The number of divisors of $N(P)$

(E) Answer not known

129. Let G be a non abelian group of order 6, Let H be satisfying $a^2=e, a\neq e$ then order of H is

(A) 1

(B) 2

(C) 3

(D) 4

(E) Answer not known

130. If P is a prime number and $P/O(G)$, then G has an element of order P is

(A) Lagranges theorem
(B) Sylows theorem
(C) Cauchy theorem
(D) Fermat's theorem
(E) Answer not known

131. If G is a group of order 28 then G has a subgroup of order

(A) 5
(B) 15
(C) 7
(D) 6
(E) Answer not known

132. Which of the following statements are false?

(i) Any group of prime order can have no proper subgroups
(ii) Any group of prime order can have proper subgroups
(iii) The order of a subgroups divides the order of a group
(iv) The order of a subgroups does not divides the order of a group

(A) (i) and (iii) only
(B) (i) and (iv) only
(C) (ii) and (iii) only
(D) (ii) and (iv) only
(E) Answer not known

133. A complex number is said to be an algebraic number if it is algebraic over a field of

(A) $\mathbb{Q}$

(B) $\mathbb{R}$

(C) $\mathbb{N}$

(D) $\mathbb{C}$

(E) Answer not known

134. If T_1 and T_2 are normal operators on a Hilbert space H with the property that either commutes with adjoint of the other then which of the following statements are TRUE?

(i) $T_1 + T_2$ is normal

(ii) $T_1 T_2$ is normal

(A) (i) only

(B) (ii) only

(C) Both (i) and (ii)

(D) Neither (i) nor (ii)

(E) Answer not known

135. Holder's inequality becomes Cauchy's inequality at

(A) $p = 2, q = 2$

(B) $p = 1, q = 1$

(C) $p = 0, q = 0$

(D) $p = 2, q = 1$

(E) Answer not known

136. Let M be a closed linear subspace of a normed linear space N. If the norm of a coset $x+M$ in the quotient space N/M is defined by _____ then N/M is a normed linear space

(i) $\|x+M\| < \inf\{\|x+m\| : m \in M\}$

(ii) $\|x+M\| > \inf\{\|x+m\| : m \in M\}$

(iii) $\|x+M\| = \inf\{\|x+m\| : m \in M\}$

(A) (ii) only

(B) (iii) only

(C) Both (i) and (iii)

(D) Both (ii) and (iii)

(E) Answer not known

137. Let $C(T)$ denote the linear space of all bounded continuous real valued function on a topological space T. Then $C(T)$ is a Banach space with the norm, $\|f\| =$

(A) $Inf\{f(x); x \in X\}$

(B) $Sup\{f(x); x \in X\}$

(C) $Sup\{|f(x)|; x \in X\}$

(D) $Inf\{|f(x)|; x \in X\}$

(E) Answer not known

138. If T is an operator on Hilbert Space H and T^* is its adjoint then

(A) $\|T^*T\| = \|T\|$

(B) $\|T^*T\| = \|T\|^2$

(C) $\|T^*T\| < \|T\|^2$

(D) $\|T^*T\| = 0$

(E) Answer not known

139. If M and N are closed linear subspaces of a Hilbert space H such that $M \perp N$, then the linear subspace $M+N$ is also

(A) Open

(B) Closed

(C) Union

(D) Disjoint

(E) Answer not known

140. Let N and N' be normed linear spaces and T a linear transformation of N into N'. Then there exists a real number $k \geq 0$ with the property that $\|T(x)\| \leq K\|x\|$ for every $x \in N$. Then T is called as a

(A) Bounded linear transformation

(B) One-to-one linear transformation

(C) Natural linear transformation

(D) Open mapping

(E) Answer not known

141. Choose the right statements from the following :

(i) Monotonic functions have only discontinuities of second kind

(ii) Monotonic functions have only discontinuities at zero

(iii) Monotonic functions have no discontinuities of first kind

(iv) Monotonic functions have no discontinuities of the second kind

(A) (i) and (ii) are true

(B) (i) and (iii) are true

(C) (iii) alone is true

(D) (iv) alone is true

(E) Answer not known

142. Match the following :

(a) $f(x)=\frac{|x|}{x}, x \neq 0$

(b) $f(x)=\begin{cases}1, & \text{if } x \text{ is rational} \\ 0, & \text{if } x \text{ is irrational}\end{cases}$

(c) $f(x)=\begin{cases}\frac{1}{x}, & x \neq 0 \\ A, & x=0\end{cases}$

1. Discontinuity of the second kind at each x
2. Simple discontinuity at $x=0$
3. Discontinuity of the second kind at $x=0$

	(a)	(b)	(c)
(A)	1	3	2
(B)	2	1	3
(C)	2	3	1
(D)	1	2	3

(E) Answer not known

143. Which among the following statements are correct?

Let E be a non compact set in R', then

(i) There exists a continuous function on E which is not bounded

(ii) There exists a continuous function and bounded function on E which has no maximum, if E is bounded then

(iii) These exists a continuous function on E which is not uniformly continuous

(A) (i) only

(B) (ii) only

(C) (i) and (iii) only

(D) All the above

(E) Answer not known

144. If there exists a positive number M such that $\sum_{K=1}^{n} |\Delta f_k| \leq M$ for all partitions of $[a, b]$, then f is said to be of _____ variation on $[a, b]$.

(A) equal

(B) less than

(C) bounded

(D) unbounded

(E) Answer not known

145. Suppose $\{x_n\}$, $\{y_n\}$ are sequences is R^k, $\{\beta_n\}$ is a sequence of real numbers and $x_n \to x$, $y_n \to y$, $\beta_n \to \beta$ then

(i) $\lim_{n\to\infty}(x_n + y_n) = x + y$

(ii) $\lim_{n\to\infty} x_n, y_n = xy$

(iii) $\lim_{n\to\infty} \beta_n x_n = \beta_n x$

Which of these are correct?

(A) (i) and (ii)

(B) (ii) and (iii)

(C) (i) and (iii)

(D) All the three

(E) Answer not known

146. The set $\mathbb{R}^n$ with d' defined by $d'(x, y) = \sum_{i=1}^{n} |x_i - y_i|$ is a

(A) Metric space

(B) Not a metric space

(C) Symmetry property of a metric alone fails

(D) Triangle inequality property of a metric alone fails

(E) Answer not known

147. Which among the following statements are correct suppose f is differentiable in (a, b)?

(i) If $f'(x) \geq 0$ for all $x \in (a, b)$, then f is monotonically increasing

(ii) If $f'(x) = 0$ for all $x \in (a, b)$, then f is constant

(iii) If $f'(x) \leq 0$ for all $x \in (a, b)$, then f is monotonically decreasing

(A) (i) only
(B) (ii) only
(C) (i) and (iii) only
(D) (i), (ii) and (iii)
(E) Answer not known

148. If f is continuous on $[a, b]$ and $f'(x) > 0$ in $]a, b[$, then f is

(A) Strictly increasing in $[a, b]$
(B) Strictly decreasing in $[a, b]$
(C) Increasing in $[a, b]$
(D) Decreasing in $[a, b]$
(E) Answer not known

149. Consider the following four statements

(i) Every differential function is continuous

(ii) Every continuous function is Riemann integrable

(iii) Every Riemann integrable function is continuous

(iv) Every continuous function is differentiable

Then

(A) both (iv) and (iii) are true

(B) both (i) and (ii) are true

(C) both (ii) and (iii) are true

(D) both (i) and (iv) are true

(E) Answer not known

150. Which among the following statements are correct?

(i) If f is monotonic on $[a, b]$ then $f \in BV[a, b]$.

(ii) If f is continuous on $[a, b]$ and f' exists and is bounded on the interval (a, b) then $f \in BV[a, b]$.

(iii) If $f \in BV[a, b]$, then f is bounded.

(A) (i), (ii) and (iii)

(B) (i) and (iii) only

(C) (ii) and (iii) only

(D) (i) and (ii) only

(E) Answer not known

151. The Taylor series expansion of $\sin z$ about $z = 0$ is

(A) $\sum_{n=1}^{\infty} a_n (z-0)^{2n-1}$ where $a_n = \dfrac{(-1)^{n-1}}{(2n-1)!}$

(B) $\sum_{n=0}^{\infty} a_n (z)^{2n-1}$ where $a_n = \dfrac{(-1)^{n-1}}{(2n-1)!}$

(C) $\sum_{n=2}^{\infty} a_n z^{n-1}$ where $a_n = \dfrac{(-1)^{n}}{n!}$

(D) $\sum_{n=1}^{\infty} a_n z^{n}$ where $a_n = \dfrac{(-1)^{n+1}}{n!}$

(E) Answer not known

152. The series $1 - z^2 + z^4 - z^6 + \ldots$ is the Taylor's series expansion of

(A) $(1+z)^2$

(B) $\dfrac{1}{1+z^2}$

(C) $\dfrac{1}{1+z}$

(D) $\dfrac{1}{z}$

(E) Answer not known

153. The Taylor series for $\cosh z$ about the point $z_0 = -2\pi i$ is

(A) $\cosh z = \sum_{n=1}^{\infty} \frac{z^{2n+1}}{(2n+1)!}$ $\quad |z| < \infty$

(B) $\cosh z = \sum_{n=0}^{\infty} (-1)^n \frac{z^{2n}}{(2n)!}$ $\quad |z| < \infty$

(C) $\cosh z = \sum_{n=0}^{\infty} \frac{(z+2\pi i)}{(2n)!}$ $\quad |z| < \infty$

(D) $\cosh z = \sum_{n=0}^{\infty} \frac{(z+2\pi)^{2n}}{(2n)!}$ $\quad |z| < \infty$

(E) Answer not known

154. The maclaurin's series expansion of $\left[(1-z)(1+z^2)^2\right]^{-1}$ is

(A) $1+z-z^2-z^3+2z^4+2z^5-\ldots$

(B) $1-z-z^2-z^3-2z^4-2z^5-\ldots$

(C) $1+z+z^3+z^5+\ldots$

(D) $1-z^2-z^4-z^6-\ldots$

(E) Answer not known

155. Which of the following is / are true?

(i) A non constant analytic function maps open sets onto open sets

(ii) If $f(z)$ is analytic and non-constant in a region Ω, then its absolute value $|f(z)|$ has no maximum in Ω.

(iii) A non-constant harmonic function has neither a maximum nor a minimum in its region of definition.

(A) (i) only
(B) (i) and (iii) only
(C) (ii) and (iii) only
(D) (i), (ii) and (iii)
(E) Answer not known

156. In Laurent's series $f(z) = \sum_{n=-\infty}^{\infty} a_n (z-a)^n$, $a_n =$

(A) $\frac{1}{2\pi i} \sum_{-\infty}^{\infty} \frac{f(s)}{(s-a)^{n+1}}$
(B) $\frac{1}{2\pi i} \int_r \frac{f(s)}{(s-a)^{n+1}} ds$
(C) $\int_r \frac{f(s)ds}{(2-a)^{n+1}}$
(D) $\frac{1}{2\pi i} \sum_{0}^{\infty} \frac{f(s)}{(s-a)^{n+1}}$
(E) Answer not known

157. What is the poles of the function $\cot z$?

(A) 1
(B) 0
(C) ∞
(D) None of these
(E) Answer not known

158. If $f(z)=\frac{\sin z}{Z^r}$; $r \geq 2$ is a positive integer, at $z=0$ has a pole of order

(A) r (B) $r-1$

(C) $r+1$ (D) 0

(E) Answer not known

159. The residue of the integral $\int_c Z^2 \sin\left(\frac{1}{z}\right) dz$ is

(A) $\frac{\pi i}{3}$ (B) $-\frac{\pi i}{3}$

(C) $2\pi i/3$ (D) $-2\pi i/3$

(E) Answer not known

160. The function $f(z)=\frac{\sin z}{z}$ has at $z=0$

(A) a simple pole

(B) an essential singularity

(C) a removable singularity

(D) a pole of order 2

(E) Answer not known

161. If $f(x, y, p, q) = 0$ then the Auxiliary equation of the Charpit's methods are

(A) $dx/f_p = dy/f_q = dz/pf_p + qf_q = \dfrac{dp}{-(f_x + Pf_z)} = \dfrac{dq}{-(f_y + qf_z)}$

(B) $\dfrac{dx}{f_q} = \dfrac{dy}{f_p} = \dfrac{dz}{qf_p + pf_q} = \dfrac{dp}{(f_x + pf_z)} = \dfrac{dq}{(f_y + qf_z)}$

(C) $\dfrac{dx}{f_p} = \dfrac{dy}{f_q} = \dfrac{dz}{pf_p - qf_q} = \dfrac{dp}{-(f_x + qf_z)} = \dfrac{dq}{-(f_y + pf_z)}$

(D) $-\dfrac{dx}{f_p} = -\dfrac{dy}{f_q} = \dfrac{dz}{(pf_p + qf_q)} = \dfrac{dp}{-(f_x + pf_z)} = \dfrac{dq}{-(f_y + qf_z)}$

(E) Answer not known

162. The partial differential equations, $xp - yq = x$ and $x^2p + q = xz$ are

(A) Not compatible

(B) Compatible with the solution $z = x + c(1 + xy)$

(C) Compatible with the solution $z = xy + c$

(D) No solution

(E) Answer not known

163. The general solution of $x(y-z)\frac{\partial z}{\partial x} + y(z-x)\frac{\partial z}{\partial y} = z(x-y)$ is

(A) $\phi(x+y+z, xyz) = 0$ ϕ being an arbitrary function

(B) $\phi\left(x+y+z, x^2+y^2+z^2\right) = 0$ ϕ being an arbitrary function

(C) $\phi\left(xyz, x^2+y^2+z^2\right) = 0$ ϕ being an arbitrary function

(D) $\phi(xyz, xy+yz+zx) = 0$ ϕ being an arbitrary function

(E) Answer not known

164. The general Integral value of the given linear partial differential equation $(y+zx)p - (x+yz)q = x^2 - y^2$ is

(A) $F\left(x^2-y^2-z^2, xy-z\right) = 0$

(B) $F\left(x^2+y^2-z^2, xy+z\right) = 0$

(C) $F\left(x^2+y^2, x-z\right) = 0$

(D) $F\left(x^2-z^2, x-y\right) = 0$

(E) Answer not known

165. The complete integral of $q = 3p^2$ is

(A) $z = ax^2 + b$

(B) $z = ax + by + c$

(C) $z = ax + 3a^2y + b$

(D) $z = ax^2 + by^2$

(E) Answer not known

166. The general integral of the linear partial differential equation $y^2p - xyq = x(z-2y)$ is

(A) $F\left(x^2+y^2, y^2-yz\right) = 0$

(B) $F\left(xy, x^2-y^2\right) = 0$

(C) $F\left(y-2, (x-y)^2\right) = 0$

(D) $F\left(x^2+y^2, y-2z\right) = 0$

(E) Answer not known

167. First order equation of the form $f(p,q)=0$ has a solution of the form

(A) $z = ax + Q(a)y + b$

(B) $z = ax^2 + Q(a)y^2 + b$

(C) $z = ax + Q(a)y^2 + b$

(D) $z = ax^2 + Q(a)y + b$

(E) Answer not known

168. If α is a constant, $\mathrm{Re}(\alpha) \geq 0$, The Bessel equation of order α is

(A) $x^2y'' + xy' - (x^2 - \alpha^2)y = 0$

(B) $x^2y'' + xy' + (x^2 - \alpha^2)y = 0$

(C) $x^2y'' - xy' + (x^2 - \alpha^2)y = 0$

(D) $x^2y'' - xy' - (x^2 - \alpha^2)y = 0$

(E) Answer not known

169. $\int xJ_0(x)\,dx =$

(A) $xJ_1(x) - J_0(x)$

(B) $xJ_1(x)$

(C) $J_1(x)$

(D) $x^2J_n(x)$

(E) Answer not known

170. Consider the Statements :

(i) Bessel function of zero order of the first kind converges for $|x| < \infty$

(ii) Bessel function of zero order of the second kind converges for $|x| < \infty$

(A) (i) only correct
(B) (ii) only correct
(C) (i) and (ii) both are incorrect
(D) (i) and (ii) both are correct
(E) Answer not known

171. Consider the second order homogeneous linear differential equation

$$p_0(x)\frac{d^2y}{dx^2} + p_1(x)\frac{dy}{dx} + p_2(x)y = 0 \quad \text{— (1)}$$

where $p_0(x), p_1(x), p_2(x)$

are polynomials in x with, $y = x^m(a_0 + a_1x + \cdots + \infty)$ — (2)

then to obtain its series solution when $x = 0$ is a regular singular point of the equation rearrange the statements below :

(1) Equate to zero the coefficients of other powers of x, to find $a_1, a_2, \ldots$, in terms of a_0

(2) Substitute the values of $a_1, a_2, a_3, \ldots$ in (2) to get series solution of given differential equation

(3) Substitute the value of $y, \frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$

(4) Equate to zero the coefficient of lowest power of x, to obtain quadratic equation called indicial equation.

(A) (4), (3), (2), (1)
(B) (4), (3), (1), (2)
(C) (3), (4), (1), (2)
(D) (3), (4), (2) (1)
(E) Answer not known

172. The hypergeometric equation

$$(x - x^2)y'' + [\gamma - (\alpha + \beta + 1)x]y' - \alpha\beta y = 0$$

which has

(A) Two regular singular points

(B) Three regular singular points

(C) Four regular singular points

(D) No regular points

(E) Answer not known

173. If $p_m(x)$ is the Legendre polynomial of order m and $p(x) = 3p_3(x) + 2p_2(x) + 4p_1(x) + 5p_0(x)$ then the polynomial $p(x) =$

(A) $15x^3 + 6x^2 - x + 8$

(B) $(x^3 + 15x^2 - x + 8)/2$

(C) $(15x^3 + 15x^2 - x + 8)/2$

(D) $(15x^3 + 6x^2 - x + 8)/2$

(E) Answer not known

174. Identify the Legendre's equation

(A) $(1 + x^2)y'' - 2xy' + n(n+1)y = 0$

(B) $(1 - x^2)y'' - 2xy' + n(n+1)y = 0$

(C) $(1 + x^2)y'' + 2xy' - n(n+1)y = 0$

(D) $(1 - x^2)y'' + 2xy' + n(n+1)y = 0$

(E) Answer not known

175. Which of the following is/are false?

(i) Any set of functions containing a function which is identically zero on I is linearly dependent on I

(ii) Any set of functions containing a linearly dependent set is linearly dependent

(iii) A subset of a linearly independent set is linearly independent

(iv) Any set of functions containing a function which is identically zero is linearly independent on I

(A) (i) only
(B) (ii) only
(C) (iii) and (iv) only
(D) (iv) only
(E) Answer not known

176. The value $W(0)$ for the set of solutions $\left\{e^{r_1 x}, x\,e^{r_1 x}, x^2 e^{r_1 x}\right\}$ is

(A) 1
(B) –1
(C) 2
(D) –2
(E) Answer not known

177. The particular solution of $y''' - 2y'' + y = x^4 + 2x + 5$ is

(A) $x^4 - 24x^2 + 22x + 101$
(B) $x^4 + 24x^2 - 22x + 101$
(C) $x^4 + 24x^2 + 22x + 108$
(D) $x^4 - 24x^2 - 22x + 108$
(E) Answer not known

178. A point $x = x_0$ is said to be an ordinary point of the equation $p_0(x)\frac{d^2y}{dx^2} + p_1(x)\frac{dy}{dx} + p_2(x)\,y = 0$, where $p_0(x), p_1(x), p_2(x)$ are polynomials in x, if the functions.

(A) $\frac{p_1(x)}{p_0(x)}$ and $\frac{p_2(x)}{p_0(x)}$ are both analytic at $x = x_0$

(B) $\frac{p_1(x)}{p_0(x)}$ and $\frac{p_2(x)}{p_0(x)}$ are not analytic at $x = x_0$

(C) $\frac{p_0(x)}{p_1(x)}$ and $\frac{p_0(x)}{p_2(x)}$ are both analytic at $x = x_0$

(D) $\frac{p_0(x)}{p_1(x)}$ and $\frac{p_0(x)}{p_2(x)}$ are not analytic at $x = x_0$

(E) Answer not known

179. The power series solution about $x = 2$ of the initial value problem $4y'' - 4y' + y = 0,\ y(2) = 0\ \ y'(2) = 1/e$ in the closed form is

(A) $y = (x-2)e^{x-2}$

(B) $y = (x-2)e^{(x-2)/2}$

(C) $y = \frac{1}{e}(x-2)e^{(x-2)/2}$

(D) $y = (Ax + B)e^{x/2} + C$

(E) Answer not known

180. If ϕ_1 and ϕ_2 are any two solution of $L(Y) = 0$ on an interval I containing a point x_0, then $W(\phi_1, \phi_2)(x) =$ is

(A) $e^{-a_1(x_0 - x_1)}\,W(x_0)$

(B) $e^{a_1(x - x_0)}\,W(x_0)$

(C) $e^{+a_1(x_0 - x_1)}\,W(x_0)$

(D) $e^{a_1(x - x_0)}\,W(x_0)$

(E) Answer not known

181. The first curvature and the second curvature on the surface $x = a(u+v)\ \ y = b(u-v),\ z = uv$ are _____ and _____ respectively.

(A) $J = 4ab(a^2 - b^2 + uv)H^2,\ k = \dfrac{4a^2b^2}{H^3}$

(B) $J = 4ab(a^2 + b^2 + uv)/H^2,\ k = \dfrac{4a^2b^2}{H^4}$

(C) $J = 4ab\ (a^2 - b^2 + uv)/H^3, k = \dfrac{-4a^2b^2}{H^4}$

(D) $J = 4ab(a^2 + b^2 + uv)/H^3,\ k = \dfrac{-4a^2b^2}{H^4}$

(E) Answer not known

182. A point on a surface is called an umblic, if at that point

(A) $\dfrac{E}{L} = \dfrac{F}{M} = \dfrac{G}{N}$

(B) $\dfrac{E}{L} \neq \dfrac{F}{M} \neq \dfrac{G}{N}$

(C) $\dfrac{L}{E} \neq \dfrac{M}{F} \neq \dfrac{N}{G}$

(D) $\dfrac{L}{E} = \dfrac{M}{F} = \dfrac{N}{G}$

(E) Answer not known

183. The quadratic differential form $Ldu^2 + 2Mdudv + N\,dv^2$ is called _____ of the surface.

(A) First fundamental form

(B) Second fundamental form

(C) Third fundamental form

(D) Orthogonal trajectories

(E) Answer not known

184. If k_a and k_b are principal curvature, the Gaussian curvature k is

(A) $\dfrac{LN + M^2}{EG + F^2}$

(B) $\dfrac{LN - M^2}{EG - F^2}$

(C) $\dfrac{LN - M^2}{EG + F^2}$

(D) $\dfrac{LN + M^2}{EG - F^2}$

(E) Answer not known

185. Which of the following statement is correct for the edge of regression of the developable?

(A) The locus of the characteristic points

(B) The tangent of the characteristic points

(C) Both (A) and (B)

(D) The perpendicular to the characteristic points

(E) Answer not known

186. Gaussian curvature (Total curvature) is zero at

(A) Parabolic point

(B) Hyperbolic point

(C) Elliptic point

(D) Origin

(E) Answer not known

187. If k is the normal curvature is a direction making an angle ψ with the principal direction $v = \text{constant}$, then $k = k_a \cos^2\psi + k_b \sin^2\psi$ where k_a and k_b are principal curvatures at the point P on the surface. This is called

(A) Dupin's theorem

(B) Liouvill'es theorem

(C) Rodrique's formula

(D) Euler's theorem

(E) Answer not known

188. If k_a and k_b are principal curvatures, the ———————— is defined as $k = k_a k_b$.

(A) Normal curvature
(B) Principal directions
(C) Mean curvature
(D) Gaussian curvature
(E) Answer not known

189. Given two families of curves,

$$\phi(u,v) = \text{constant},$$

$$\psi(u,v) = \text{constant}$$

the condition that determines they form a conjugate system is

(A) $L\phi_2\psi_2 - M(\phi_1, \psi_2 + \phi_2\psi_1) + N\phi_1\psi_1 = 0$
(B) $L\phi_2\phi_1 - M(\phi_1\psi_2 + \phi_2\psi_1) + N\psi_1\psi_2 = 0$
(C) $L\phi_2\phi_1 - M(\phi_1\phi_2 + \psi_1\psi_2) + N\psi_1\psi_2 = 0$
(D) $L\phi_2\psi_2 - M(\phi_1\phi_2 + \psi_1\psi_2) + N\phi_1\psi_1 = 0$
(E) Answer not known

190. If $(\vec{t},\vec{n},\vec{b})$ is the moving orthogonal triad of unit vectors at a point P on a space curve γ, then

(A) $\frac{d\vec{t}}{ds} = \tau\vec{n}, \frac{d\vec{n}}{ds} = \tau\vec{b} - k\vec{t}\ \frac{d\vec{b}}{ds} = k\vec{n}$

(B) $\frac{d\vec{t}}{ds} = k\vec{n}, \frac{d\vec{n}}{ds} = \tau\vec{b} - k\vec{t}, \frac{d\vec{b}}{ds} = -\tau\vec{n}$

(C) $\frac{d\vec{t}}{ds} = \tau\vec{n}, \frac{d\vec{n}}{ds} = k\vec{b} - e\vec{n}, \frac{d\vec{b}}{ds} = k\vec{b}$

(D) $\frac{d\vec{t}}{ds} = k\vec{n}\ \frac{d\vec{n}}{ds} = k\vec{b} - \tau\vec{n}\ \frac{d\vec{b}}{ds} = 0$

(E) Answer not known

191. A necessary and sufficient condition that a curve to be constant slope is that

(A) The ratio of torsion to curvature be constant

(B) The ratio of curvature to torsion be constant

(C) The product of torsion and curvature is constant

(D) The product of torsion and curvature be zero

(E) Answer not known

192. Which among the following is a true statement?

(A) A left handed helix can be super imposed on right handed helix

(B) A left - handed helix can never be super imposed on right handed one

(C) When b is negative the helix is right handed $(z = bu)$

(D) When b is positive the helix in left handed $(z = bu)$

(E) Answer not known

193. A Necessary and sufficient condition for a curve to be a straight line is that ———————— at all point of the curve

(A) $k = 0$ (B) $k = 1$

(C) $k = -1$ (D) $k = 2$

(E) Answer not known

194. The curvature of the curve $\bar{r} = (a\cos t,\ a\sin t, at\cot\alpha)$ is given by

(A) $\dfrac{\sin\alpha}{\alpha}$ (B) $\dfrac{\cos\alpha}{\alpha}$

(C) $\dfrac{\sin^2\alpha}{a}$ (D) $\dfrac{\cos^2\alpha}{a}$

(E) Answer not known

195. The equation of the plane through three consecutive points of the curve is

(A) Osculating plane (B) Tangent plane

(C) Rectifying plane (D) Normal plane

(E) Answer not known

196. If $\hat{t}, \hat{n}, \hat{b}$ are the unit vectors of the moving trihedron, then find the incorrect matches

(1) $\hat{t}$ – unit tangent vector

(2) $\hat{n}$ – unit binormal vector

(3) $\hat{b}$ – unit normal vector

(4) Equation of osculating plane – $(\vec{y}-\vec{x})\cdot\hat{b}=0$

(5) Equation of normal plane – $(\vec{y}-\vec{x})\cdot\hat{t}=0$

(6) Equation of rectifying plane – $(\vec{y}-\vec{x})\cdot\hat{n}=0$

(A) (1) and (4) only
(B) (4) and (5) only
(C) (2) and (3) only
(D) (5) and (6) only
(E) Answer not known

197. Assertion [A] : It is possible to characterize a curve by a relation independent of the coordinates.

Reason [R] : Equation independent of the coordinates is called natural or intrinsic.

(A) [A] is true [R] is false
(B) Both [A] and [R] are true; [R] is the correct explanation of [A]
(C) [A] is false [R] is true
(D) Both [A] and [R] are true; but [R] is not the correct explanation of [A]
(E) Answer not known

198. Analytical representation of the space curve circle in terms of arc length is

(A) $x = a\cos s,\ y = a\sin s,\ z = 0$

(B) $x = a\cos\left(\frac{s}{a}\right),\ y = b\sin\left(\frac{s}{a}\right),\ z = 0$

(C) $x = a\cos\left(\frac{s}{a}\right),\ y = a\sin\left(\frac{s}{a}\right),\ z = 0$

(D) $x = a\cos s,\ y = b\sin s,\ z = 0$

(E) Answer not known

199. Match the following

(a) Curvature of involute 1. $\dfrac{k\tau' - k'\tau}{k(c-s)\left(\tau^2 + k^2\right)}$

(b) Torsion of involute 2. $-\dfrac{k^3\sin(\psi+c)\cos^2(\psi+c)}{k\tau\sin(\psi+c) - k'\cos(\psi+c)}$

(c) Curvature of evolute 3. $\dfrac{\left(\tau^2 + k^2\right)^{\frac{1}{2}}}{k(c-s)}$

(d) Torsion of evolute 4. $\dfrac{k^3\cos^2(\psi+c)}{k\tau\sin(\psi+c) - k'\cos(\psi+c)}$

	(a)	(b)	(c)	(d)
(A)	4	1	2	3
(B)	3	1	4	2
(C)	2	1	4	3
(D)	3	1	2	4

(E) Answer not known

200. Match the following curve/surface with its curvature (k) and Torsion (τ) and choose the right option :

Curve/surface		Curvature (k)		Torsion (τ)
(1) $r = f(u)$	(i)	$\frac{\lvert H \rvert}{\lvert h \rvert^3}$	(a)	$\frac{[r', r'', r''']}{[r' \times r'']^2}$
(2) $r = f(s)$	(ii)	$\frac{\dot{r} \times \ddot{r}}{\lvert \dot{r} \rvert^3}$	(b)	$\frac{-\Delta h \cdot \Delta H}{\lvert H \rvert^2}$
(3) Intersection of two surfaces	(iii)	$[r' \times r'']$	(c)	$\frac{\dot{r}, \ddot{r}, \dddot{r}}{[\dot{r} \times \ddot{r}]^2}$

(A) (1)-(ii)-(c), (2)-(iii)-(a), (3)-(i)-(b)
(B) (2)-(ii)-(c), (1)-(iii)-(a), (3)-(i)-(b)
(C) (3)-(ii)-(c), (1)-(iii)-(a), (2)-(i)-(b)
(D) (1)-(i)-(b), (2)-(iii)-(a), (3)-(ii)-(c)
(E) Answer not known