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ROY'S INSTITUTE OF COMPETITIVE EXAMINATION

The West Bengal Central School Service Commission

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MATHEMATICS

[CLASSES : XI - XII]

1. If a plane has intercepts l, m, n on the axes and be at a distance 'p' from the origin, then

   (A) $l^2 + m^2 + n^2 = p^2$

   (B) $l^{-2} + m^{-2} + n^{-2} = p^2$

   (C) $l^{-2} + m^{-2} + n^{-2} = p^{-2}$

   (D) $l^2 + m^2 + n^2 = p^{-2}$

2. Which of the following statements is false?

   (A) The arbitrary union of open sets is open.

   (B) The arbitrary union of closed sets is closed.

   (C) The arbitrary intersection of closed sets is closed.

   (D) The finite intersection of closed sets is closed.

3. Let $A = \begin{vmatrix} 1 & -1 & 0 \\ 1 & 2 & -1 \\ 3 & 2 & -2 \end{vmatrix}$. Then the eigenvalues of A are

   (A) 1, 1, 1

   (B) –1, –1, 1

   (C) 1, 1, –1

   (D) –1, –1, –1

4. The vector equation $\vec{r} = \vec{a} + t\vec{b}$ (t, a parameter; $\vec{a}, \vec{b}$ constant vectors), represents

   (A) a straight line passing through points having position vectors $\vec{a}$ and $\vec{b}$.

   (B) a straight line passing through point $\vec{a}$ and parallel to $\vec{b}$.

   (C) a straight line passing through point $\vec{a}$ and perpendicular to $\vec{b}$.

   (D) a straight line perpendicular to both $\vec{a}$ and $\vec{b}$.

5. The rank of the matrix $\begin{pmatrix} 2 & 1 & 4 & 3 \\ 3 & 2 & 6 & 9 \\ 1 & 1 & 2 & 6 \end{pmatrix}$ is

   (A) 3

   (B) 1

   (C) 2

   (D) 4

6. Let A be a real square matrix of order 3. Then which of the following statements is always true?

   (A) $tr(AA^T) = 0$

   (B) $tr(AA^T) \geq 0$

   (C) $tr(AA^T) \leq 0$

   (D) $tr(AA^T) \neq 0$

7. Due to application of the force $\vec{F} = 3\hat{i} + 2\hat{j} + 4\hat{k}$ a particle changes its position from the point $\hat{i} + \hat{j} + \hat{k}$ to the point $2\hat{i} - 3\hat{j} + 4\hat{k}$. The work done by the force is

   (A) 7 unit

   (B) 5 unit

   (C) 0 unit

   (D) 2 unit

8. Let $f(x, y) = x^5y^2 \tan^{-1}\left(\frac{y}{x}\right)$. Then $x\frac{\partial f}{\partial x} + y\frac{\partial f}{\partial y}$ equals to

   (A) $2f(x, y)$

   (B) $7f(x, y)$

   (C) $3f(x, y)$

   (D) $5f(x, y)$

9. Let $\{x_n\}_1^{\infty}$ be a convergent sequence of real numbers. Then the sequence $\{x_n\}_1^{\infty}$ is

(A) bounded.

(B) unbounded.

(C) bounded below but unbounded above.

(D) bounded above but unbounded below.

10. The operation div$(\vec{r})$ gives

(A) 3

(B) 0

(C) $\vec{r}$.

(D) $3\vec{r}$

11. Which of the following sets is not countable?

(A) $\left\{\frac{1}{n} : n \in \mathbb{N}\right\}$

(B) $\mathbb{Z}$

(C) $\{\sqrt{x} : x \in (0,1)\}$

(D) $\{x \in \mathbb{R} : \sin x = 0\}$

12. The function $y = |x - 2025|$, $x \in \mathbb{R}$ is continuous

(A) only at x = 2025.

(B) everywhere except at x = 2025.

(C) only at x = 0

(D) everywhere

13. Consider the statement "For each *n*, there exists an abelian group of order *n*". — In this statement *n* is

(A) any positive integer.

(B) only a prime number.

(C) only an even integer.

(D) only an odd integer.

14. The minimum value of $3x + 2y$ when x, y are positive real numbers satisfying the condition $x^2y^3 = 48$ is

(A) 10

(B) 5

(C) $\frac{48}{5}$

(D) $\frac{5}{48}$

15. $\lim_{x\to\infty}\left(1+\frac{1}{2n}\right)^{3n}$ is equal to

(A) $e^{2/3}$

(B) $e^{3/2}$

(C) e

(D) 0

16. In a simplex method, if there is a tie in selecting the departing vectors, the next solution is bound to be

(A) optimal

(B) infeasible

(C) non-degenerate

(D) degenerate

17. $\Delta^{10}[(1 - ax)(1 - bx^2)(1 - cx^3)(1 - dx^4)]$ has the value

(A) 0

(B) 1

(C) $abcd$

(D) $10!abcd$

18. If G be a group of order p^2 where p is a prime, then G must

(A) be a cyclic group.

(B) be a non-commutative group.

(C) be a commutative group.

(D) have an element of order 2.

19. The order of convergence of Newton-Raphson method is

(A) 1

(B) 2

(C) 3

(D) 4

20. For all α, ß in a Euclidean space V

(A) (α, ß) = 0 implies ||α + β|| = ||α – β|| but not conversely.

(B) ||α + β|| = ||α – β|| implies (α, ß) = 0 but not conversely.

(C) ||α + ß|| = ||α – ß|| implies and implied by (α, ß) = 0

(D) The relations ||α + β|| = ||α – β|| and (α, ß) = 0 are independent.

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21. $\int_{-1}^{3}|x|dx$ has been evaluated numerically by Trapezoidal and Simpson's $\frac{1}{3}$ rule, taking equal sub-intervals. Then

(A) Trapezoidal rule gives the better result than Simpson's $\frac{1}{3}$ rule.

(B) Simpson's $\frac{1}{3}$ rule gives the better result than Trapezoidal rule.

(C) Both the rules give better result.

(D) The results of these two methods cannot be compared

22. Let $f(x) = \begin{cases} x, & x \in \mathbb{Q} \\ 2-x, & x \in \mathbb{R}\setminus\mathbb{Q} \end{cases}$. Then $\lim_{x \to c} f(x)$ exists

(A) for all values of $c \in \mathbb{R}$.

(B) for $c \neq 1$.

(C) for c = 1 only.

(D) for no values of c.

23. The K.E. of a body rotating about an axis is—

(A) $\frac{1}{2}MK^2\dot{\theta}^2$

(B) $MK^2\dot{\theta}^2$

(C) $\frac{1}{3}MK^2\dot{\theta}^2$

(D) $MK^2\ddot{\theta}$

(M-mass of the body, K-radius of gyration about the axis, θ-angle between a line fixed in body and a line fixed in space)

24. The value of $\begin{vmatrix} a^2 & a & 1 \\ b^2 & b & 1 \\ c^2 & c & 1 \end{vmatrix}; a,b,c \in \mathbb{R}$ is

(A) $(a-b)(b-c)(c-a)$

(B) $-(a-b)(b-c)(c-a)$

(C) $(a-b)(b+c)(c-a)$

(D) $-(a-b)(b+c)(c-a)$

25. A relation ρ on $\mathbb{Z}$ defined by $a\rho b$ ($a, b \in \mathbb{Z}$) holds if and only if $a - b < 3$. Then

(A) ρ is only reflexive.

(B) ρ is reflexive and symmetric.

(C) ρ is reflexive and transitive.

(D) ρ is an equivalence relation.

26. If $x^3 + 3px + q$ ($p, q \in \mathbb{R}$) has a factor of the form $(x-\alpha)^2$, then

(A) $p^2 + 4q = 0$

(B) $p^2 + 4q^3 = 0$

(C) $q^2 + 4p^3 = 0$

(D) $q^2 + 4p = 0$

27. The 3rd central moment for Normal distribution $N(\mu, \sigma)$ is

(A) $3\sigma^3$

(B) $2\sigma^3$

(C) σ^3

(D) 0

28. The area of the region bounded by $x = \pm 1$, $y = 0$ and $y = x^2$ is

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

(B) $\frac{2}{3}$ square unit

(C) 1 square unit

(D) 2 square unit

29. Let $y_1(x)$ and $y_2(x)$ be two solutions of $\frac{dy}{dx} = x$ with the initial conditions $y_1(0) = 0$ and $y_2(0) = 1$. Then

(A) y_1 and y_2 will intersect at the origin.

(B) y_1 and y_2 will intersect at (0, 1).

(C) y_1 and y_2 will intersect at (1, 0).

(D) y_1 and y_2 will never intersect

30. Let $A = \left\{1, 1+\frac{1}{1!}, 1+\frac{1}{1!}+\frac{1}{2!}, 1+\frac{1}{1!}+\frac{1}{2!}+\frac{1}{3!}, \cdots\right\}$ The supremum of A

(A) is an irrational number.

(B) is a rational number.

(C) does not exist.

(D) is an integer.

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31. If A contains 2 elements and B contains 4 elements, then the power set of $A \times B$ will contain

(A) 2^6 elements

(B) 2^{2^3} elements

(C) 2^{3^2} elements

(D) 3^{2^2} elements

32. If each proper subgroup of a group is commutative, then the group

(A) is always commutative.

(B) is always cyclic.

(C) is of prime order.

(D) may not be a commutative group.

33. The equation of the straight line through the point (α, β, γ) which is parallel to z-axis is—

(A) $\frac{x-a}{0}=\frac{y-b}{0}=\frac{z-g}{1}$

(B) $\frac{x-\alpha}{1}=\frac{y-\beta}{1}=\frac{z-\gamma}{0}$

(C) $\frac{x-\alpha}{1}=\frac{y-\beta}{1}=\frac{z-\gamma}{1}$

(D) $\frac{x-\alpha}{1}=\frac{y-\beta}{0}=\frac{z-\gamma}{1}$

34. If $J_n = \int_0^{\pi/4} \tan^n x \, dx$ where $n \in \mathbb{N} - \{1\}$ then

(A) $J_n + J_{n-2} = \frac{-1}{n-1}$

(B) $J_n - J_{n-2} = \frac{1}{n-1}$

(C) $J_n + J_{n-2} = \frac{1}{n-1}$

(D) $J_n - J_{n-2} = \frac{-1}{n-1}$

35. The line segment $x + 2y = 1$ $(0 \le x \le 1)$ is revolved about x-axis through 360°. Then the volume of the solid generated is—

(A) $\frac{\pi}{6}$ cubic unit

(B) $\frac{\pi}{12}$ cubic unit

(C) $\frac{\pi}{8}$ cubic unit

(D) $\frac{\pi}{10}$ cubic unit

36. The value of $\int_0^{\pi} \frac{x \sin x}{1+\cos^2 x} dx$ is

(A) 0

(B) 1

(C) $\frac{\pi^2}{4}$

(D) $\frac{\pi^2}{2}$

37. Let V be a real vector space with $\{\alpha, \beta, \gamma)$ as a basis and let $S = \{\alpha+\beta+\gamma, \beta+\gamma, \gamma\}$. Then

(A) S is linearly dependent.

(B) S is linearly independent but $L(S) \neq V$.

(C) S is a basis of V.

(D) $L(S)$ is not a subset of V.

38. The probability of getting the r-th success at the n-th trial of a Bernouli trial $B(n, p)$ is

(A) ${}^nC_r\, p^r q^{n-r}$

(B) ${}^{n-1}C_{r-1}\, p^r q^{n-r}$

(C) ${}^{n-1}C_{r-1}\, p^{r-1} q^{n-r}$

(D) ${}^{n-1}C_{r-1}\, p^r q^{n-r-1}$

39. The number of generators of the group $(\mathbb{Z}_{100}, +)$ of integers modulo 100 is—

(A) 9

(B) 40

(C) 12

(D) 8

40. If a particle moves on a plane such that its radial and cross radial velocities are equal, then its path will be

(A) circle

(B) straight line

(C) equiangular spiral

(D) ellipse

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41. Let $f_n(x) = x^n$, $x \in [0, 1]$ and $n \in \mathbb{N}$. Then

(A) $\{f_n\}_{n=1}^{\infty}$ is not pointwise convergent on [0, 1].

(B) $\{f_n\}_{n=1}^{\infty}$ is pointwise convergent but not uniformly convergent on [0, 1].

(C) $\{f_n\}_{n=1}^{\infty}$ is uniformly convergent on [0, 1].

(D) $\{f_n\}_{n=1}^{\infty}$ is convergent only for x = 0.

42. The linear map $T : \mathbb{R}^3 \to \mathbb{R}^3$ is defined by $T(x, y, z) = (x - y, x + 2y, y + 3z)$, $(x, y, z) \in \mathbb{R}^3$. Then rank of T is

(A) 0

(B) 1

(C) 2

(D) 3

43. The pole of the plane $lx + my + nz = p$ with respect to the sphere $x^2 + y^2 + z^2 = a^2$ is

(A) (al^2, am^2, an^2)

(B) (la^2, ma^2, na^2)

(C) $\left(\frac{la^2}{p}, \frac{ma^2}{p}, \frac{na^2}{p}\right)$

(D) (lpa^2, mpa^2, npa^2)

44. Let f be a bounded function on $[a, b]$ and P_1 be a partition of $[a, b]$. If P_2 be a refinement of P^1, then

(A) $L(P_1; f) \leq L(P_2; f)$

(B) $U(P_2; f) \leq L(P_1; f)$

(C) $U(P_1; f) \leq U(P_2; f)$

(D) $L(P_2; f) \geq U(P_1; f)$

45. Which of the following statements is false?

(A) Every cyclic group is commutative.

(B) Every group of prime order is cyclic.

(C) There exists a group of order 4 which is commutative but not cyclic.

(D) Every group of order 4 is cyclic.

46. If A be real matrix of order 3 with det $A = 9$, then det (adj$A$) equals to

(A) 18

(B) 81

(C) 9

(D) –81

47. Let A be a 3×3 real matrix with eigenvalues 1, –1, 3. Then

(A) $A^2 + A$ is non-singular.

(B) $A^2 - A$ is non-singular.

(C) $A^2 + 3A$ is non-singular.

(D) $A^2 - 3A$ is non-singular.

48. Let A be a set of 3 elements and B be a set of 4 elements. Then the total number of mappings from A to B is

(A) 3^4

(B) 4^3

(C) 12

(D) 6

49. The value of $\frac{1}{2}\int_0^{\infty} x^7 e^{-\sqrt{x}} dx$ is

(A) $\frac{15!}{2}$

(B) $\frac{16!}{2}$

(C) $2 \times 15!$

(D) 15!

50. The asymptotes of the curve $x^2 - y^2 = a^2$ are

(A) $y = \pm x$

(B) $y = \pm 2x$

(C) $y = \pm 3x$

(D) $x = 0, y = 0$

51. The radius of convergence of the power series $\sum_{n=1}^{\infty} \frac{n^n}{n!} x^n$ is

(A) e

(B) $\frac{1}{e}$

(C) e^2

(D) ∞

52. The series of function $\sum_{n=1}^{\infty} \frac{\sin nx}{n^2}, x \in \mathbb{R}$ is uniformly convergent

(A) for all $x \in \mathbb{R}$.

(B) only for $x = 0$.

(C) only for $x \in (-1, 1]$.

(D) only for $x \in [-1, 1]$.

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53. The digit in the unit place of 3^{100} is

(A) 1

(B) 3

(C) 0

(D) 9

54. The pair of straight lines $x^2 - 2pxy - y^2 = 0$ and $x^2 - 2qxy - y^2 = 0$ be such that each pair bisects the angles between the other pair, then

(A) $pq = 1$

(B) $pq = -1$

(C) $p + q = 1$

(D) $p + q = -1$

55. The principal value of argument z where $z = 1 + i\tan\frac{3\pi}{5}$ is

(A) $-\frac{2\pi}{5}$

(B) $\frac{2\pi}{5}$

(C) $\frac{\pi}{5}$

(D) $\frac{\pi}{5}$

56. The ring $(\mathbb{Z}_n, +, \cdot)$ is an integral domain if and only if

(A) n is a prime.

(B) n is an integer.

(C) n is a multiple of 2 only.

(D) n is a multiple of 3 only.

57. The M.I. of a hollow sphere about a diameter is

(A) Ma^2

(B) $\frac{1}{2}Ma^2$

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

(D) $\frac{2}{5}Ma^2$

58. If $\sum_{n=1}^{\infty} a_n$ $(a_n > 0)$ is convergent, then

(A) $\sum_{n=1}^{\infty} \frac{a_n}{a_n+1}$ is convergent.

(B) $\sum_{n=1}^{\infty} \frac{a_n}{a_n+1}$ is divergent.

(C) $\sum_{n=1}^{\infty} \frac{a_n}{a_n+1}$ oscillates infinitely.

(D) no definite conclusion can be made regarding the convergence of $\sum_{n=1}^{\infty} \frac{a_n}{a_n+1}$.

59. If the solution of the primal of an LPP be optimal, then the dual solution is

(A) optimal.

(B) feasible but not optimal.

(C) not optimal.

(D) unbounded.

60. Perpendiculars PL, PM, PN are drawn from the point $P(a, b, c)$ to the co-ordinate planes. The equation of the plane LMN is

(A) $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$

(B) $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=2$

(C) $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=0$

(D) $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=3$