MATHEMATICS

1. Arithmetic mean $\bar{X}$ of a random variable X is equal to

(A) $E(X^2)$ (B) $E(X^2)-E(X)$
(C) $E(X)$ (D) $E(X^2)-(E(X))^2$

2. A balanced coin is tossed 3 times. A man is paid Rs.5 if he gets all heads or all tails and loses Rs.3 otherwise. Then the expected gain is

(A) -2 (B) -1
(C) 2 (D) 5

3. The random variable X has variance 4 and $E(X^2)=8$. Then the mean of X is

(A) $2\sqrt{3}$ (B) ± 2
(C) 4 (D) $\pm 2\sqrt{2}$

4. If the points $(-a,a),(a,-a)$ and (a,a) enclose a triangle of area 18 sq. units then the centroid of the triangle is

(A) $(-8,-8)$ and $(8,8)$ (B) $(-3,-3)$ and $(3,3)$
(C) $(-2,-2)$ and $(2,2)$ (D) $(-1,-1)$ and $(1,1)$

5. The sum of the abscissa of all points on the line $x+y=4$ that lie a unit distance from the line $4x+3y=10$ is

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

6. A section of a sphere by a plane, in general, is

(A) a great circle (B) a circle
(C) a cone (D) a cylinder

7. If $z=i^i$ (where $i^2=-1$) then $z/\bar{z}$ is

(A) i (B) $-i$
(C) 1 (D) -1

8. If $f: R \to R$ (where R is the set of all real numbers) is defined by $f(x) = \dfrac{e^{|x|} - e^{-x}}{e^x + e^{-x}}$ then f is

(A) one-to-one and continuous
(B) neither one-to-one nor continuous
(C) one-to-one but not continuous
(D) not one-to-one but continuous

9. Let $f: \mathbb{R} \to \mathbb{R}$ be such that $f(x+y) = f(x) + f(y)$ for all $x, y \in \mathbb{R}$ and if f is continuous at $x = 0$ then f is continuous

(A) for $x \geq 0$ only
(B) for $x \leq 0$ only
(C) on the interval $(-1,1)$ only
(D) for all real x

10. If $f(a) = 4$ and $f'(a) = 1$ then $\lim_{x \to a} \dfrac{xf(a) - af(x)}{x - a}$ is equal to

(A) $2 - a$
(B) $3 - a$
(C) $4 - a$
(D) 6

11. The value of a for which the function $f(x) = a \cos x + \frac{1}{3} \cos 3x$ has an extremum at $x = \pi/6$ is

(A) 1
(B) -1
(C) 0
(D) -2

12. If $0 < x < \pi$ and $\cos x + \sin x = \frac{1}{2}$, then x lies

(A) on the line $x = 0$
(B) in the second quadrant
(C) on the line $x = 1$
(D) in the first quadrant

13. If $e^{\sin x} + e^{\cos x} = 2e^{-\frac{1}{\sqrt{2}}}$ then $\tan x$ is

(A) 1
(B) $\sqrt{3}$
(C) $\dfrac{1}{\sqrt{3}}$
(D) ∞

14. The domain of the function $f(x)=\sec^{-1}x+\tan^{-1}x$ is

(A) $(-\infty,-1]\cup[1,\infty)$
(B) $(-\infty,0]$
(C) $(-\infty,1)\cup(1,\infty)$
(D) $(-\infty,\infty)$

15. The number of one-one, onto function from A to B having the same number of elements n, is

(A) 0
(B) $n!$
(C) n
(D) $2n$

16. If $\vec{a}=3\vec{i}+4\vec{j}+5\vec{k}$ is a non zero vector and m is a non-zero scalar, then $m\vec{a}$ is a unit vector if m is equal to

(A) $5\sqrt{2}$
(B) $\frac{1}{5\sqrt{2}}$
(C) $2\sqrt{5}$
(D) $\frac{1}{2\sqrt{5}}$

17. One mapping is selected at random from all the mappings from the set $S=\{1, 2, 3,...n\}$ into itself. The probability that the selected mapping is one to one is

(A) $n!$
(B) $n!n^{n-1}$
(C) $\frac{n!}{n^n}$
(D) $n!n^n$

18. If $\theta\in\mathbb{R}$; then $\begin{vmatrix} 1 & \cos\theta & 1 \\ -\cos\theta & 1 & \cos\theta \\ -1 & -\cos\theta & 1 \end{vmatrix}$ lies in the interval

(A) $[-1, 1]$
(B) $[0, 1]$
(C) $[-2, 4]$
(D) $[2, 4]$

19. The system of equations $-4x+3y+z=1$; $2x-6y+z=-2$ and $2x+3y+\lambda z=4$ will have no solution if

(A) $\lambda=-1$
(B) $\lambda=-2$
(C) $\lambda=0$
(D) $\lambda=1$

20. Let $f(x)=\begin{vmatrix} 1+\sin^2 x & \cos x & \sin x \\ 2-\sin^2 x & \cos^2 x & \tan x \\ \sin^2 x & \cos x & -\cot x \end{vmatrix}$ then $\int_{-\pi/2}^{\pi/2} f(x)\,dx$ is

(A) 0 (B) 1
(C) 2 (D) 3

21. If $A=\begin{pmatrix} 1 & 0 \\ \frac{1}{2} & 1 \end{pmatrix}$ then A^{100} is

(A) $\begin{pmatrix} 1 & 0 \\ 50 & 1 \end{pmatrix}$ (B) $\begin{pmatrix} 1 & 0 \\ \frac{1}{50} & 1 \end{pmatrix}$
(C) $\begin{pmatrix} 1 & 0 \\ 25 & 1 \end{pmatrix}$ (D) $\begin{pmatrix} 1 & 0 \\ \frac{1}{25} & 1 \end{pmatrix}$

22. The number of integers greater than 4000 that can be formed with the digits 2, 3, 5, 7 and 9, no digit being repeated, is

(A) 190 (B) 191
(C) 192 (D) 194

23. The set of all points where the function $f(x)=x|x|$, where x is real, is differentiable is

(A) $(0,\infty)$ (B) $(-\infty, 0)$
(C) $(-\infty, 0)\cup(0, \infty)$ (D) $(-\infty,\infty)$

24. If $x=\sqrt{20+\sqrt{20+\sqrt{20+\ldots\text{upto }\infty}}}$ then x is

(A) 5 (B) 10
(C) 20 (D) 25

25. If the sum of 7 consecutive natural numbers is 2121, then the middle number is

(A) 200 (B) 202
(C) 300 (D) 303

26. If the distance of the plane $x+\frac{y}{a}+\frac{z}{4}=1$ from the origin is $\frac{4}{\sqrt{21}}$ then the value of a is

(A) 2 (B) 4
(C) 6 (D) 8

27. The equation of the curve whose subnormal is twice the abscissa is

(A) a circle (B) a parabola
(C) a hyperbola (D) an ellipse

28. If $\omega(\neq 1)$ is a cube root of unity, then the value of
$(1-\omega)(1-\omega^2)(1-\omega^4)(1-\omega^5)(1-\omega^7)(1-\omega^8)(1-\omega^{10})(1-\omega^{11})$ is

(A) 81 (B) 82
(C) -82 (D) 27

29. If $h(x)=\min(x,x^2)$ where x is a real number then

(A) $h(x)$ is increasing
(B) $h(x)$ is decreasing
(C) $h(x)$ is constant
(D) $h(x)$ is neither increasing nor decreasing

30. If $ABCD$ is a quadrilateral and the mid points P, Q, R and S of consecutive sides AB, BC, CD and DA are joined by straight lines then the quadrilateral $PQRS$ is always a

(A) square (B) parallelogram
(C) rectangle (D) rhombus

31. The equation of the normal at the point (4, 5) on the ellipse $2x^2 + 5y^2 = 20$ is

(A) $25x-8y=60$ (B) $25x-8y=90$
(C) $8x-25y=60$ (D) $3x+2y=7$

32. If a and b are negative real numbers then $|a+b|$ is

(A) $a+b$ (B) $a-b$
(C) $b-a$ (D) $-a-b$

33. The greatest integer $\leq x$ for any real number x is denoted by $[x]$.
Whenever x is not an integer then the value of $[x]+[-x]$ is

(A) 0 (B) 1
(C) -1 (D) -2

34. If $f(x)=ax^3+bx^2+cx+d$ is a cubic polynomial and has three equal real roots then $f'(x)$ has

(A) distinct roots (B) only one root
(C) no root at all (D) at least two equal roots

35. If x satisfies $x^4-10x^3+26x^2-10x+1=0$ then $x+\frac{1}{x}$ can be

(A) 1 or 2 (B) 2 or 4
(C) 4 or 6 (D) 6 or 8

36. A, B are two square matrices such that $A+B=AB$ then

(A) $I-A$ is invertible
(B) neither $I-A$ nor $I-B$ is invertible
(C) $I-B$ is invertible
(D) both $I-A$ and I – B are invertible

37. The solutions of the equation $\frac{x}{y}+\frac{y}{x}-\frac{1}{xy}=2$ are

(A) $(a,a+1),(-a,a+1)$ (B) $(a,a-1),(-a,a-1)$
(C) $(a,a+1),(a,a-1)$ (D) $(-a,a+1),(-a,a-1)$

38. The locus of a complex number z which satisfy $\left|\frac{z+3i}{z-3i}\right|=1$ is

(A) $\text{Re}(z)>0$ (B) x – axis
(C) y – axis (D) $\text{Re}(z)<0$

39. The roots of the equation $x^2-px+q=0$ are $\cot 30^\circ$ and $\cot 15^\circ$. Then $q-p$ is

(A) -1 (B) 0
(C) 2 (D) 1

40. Suppose $\begin{vmatrix} 1 & 2\lambda & 3 \\ 2 & 0 & 1 \\ 1 & \lambda & -1 \end{vmatrix} + 5 \begin{vmatrix} \lambda & 3 & 2 \\ 4 & 3 & 2 \\ \lambda & 1 & 0 \end{vmatrix} = 0$ then λ is equal to

(A) -40 (B) 40
(C) 20 (D) -20

41. If $\omega \neq 1$ is a cube root of unity then $\begin{vmatrix} i & i\omega & i\omega^2 \\ -\omega & -\omega^2 & -1 \\ 1 & i & -i \end{vmatrix}$ is equal to

(A) ω (B) i
(C) 0 (D) 1

42. The graph of the function $y = \sin x \sin(x-2) - \sin^2(x-1)$ is

(A) a straight line passing through $(0, -\sin^2 1)$ parallel to x axis
(B) a straight line passing through $(0, 0)$
(C) a straight line passing through $(0, -\sin^2 1)$ perpendicular to x axis
(D) a parabola with vertex $(1, -\sin^2 1)$

43. If $\sin\alpha, \cos\alpha$ are the roots of the equation $ax^2 + bx + c = 0, (c \neq 0)$ then

(A) $(b+c)^2 = a^2 + c^2$ (B) $(b-c)^2 = a^2 - c^2$
(C) $(a-c)^2 = b^2 - c^2$ (D) $(a+c)^2 = b^2 + c^2$

44. The function $L(x) = \int_0^x e^t \, dt + 1$ satisfies the equation

(A) $L(x-y) = L(x)/L(y)$ (B) $L(xy) = L(x) + L(y)$
(C) $L\left(\frac{x}{y}\right) = L(x) + L(y)$ (D) $L(x+y) = L(x) + L(y)$

45. The value of $\int \frac{\cos 4x + 1}{\cot x - \tan x} dx$ is equal to

(A) $\frac{1}{6}\cos 4x + C$
(B) $-2\cos 4x + C$
(C) $-\frac{1}{8}\cos 4x + C$
(D) $-\frac{1}{4}\cos 4x + C$

46. The number of distinct circular permutations of n different objects is

(A) $n!$
(B) $(n-1)!$
(C) n
(D) $\binom{n}{2}$

47. The numbers e and π are

(A) both rationals
(B) e rational and π irrational
(C) π rational and e irrational
(D) both irrationals

48. $\lim_{x \to 0} \frac{\int_0^x \cos t^2 dt}{\sin x}$ is equal to

(A) -1
(B) 1
(C) 0
(D) -2

49. Let G be the set of all whole numbers. Define a relation $*$ on $G \times G$ by $a * b = a + b - 2$ for $a, b \in G$. Then $*$ is

(A) a binary operation
(B) a binary operation without inverse
(C) not a binary operation
(D) a binary operation with unit element

50. Which of the following is divisible by 13?

(A) $2^{20} + 3^{20}$
(B) $2^5 + 3^5$
(C) $2^7 + 3^7$
(D) $2^{13} + 3^{13}$

51. $\Delta = \begin{vmatrix} a & a & x \\ m & m & m \\ b & x & b \end{vmatrix}$ has the following factor(s)

(A) $(x-a)$ only
(B) $(x-b)$ only
(C) $(x-m)$ only
(D) $(x-a)$ and $(x-b)$

52. The number of permutations of the letters of ALLAHABAD is

(A) $9!$
(B) $\frac{9!}{4!}$
(C) $\frac{9!}{3!}$
(D) $\frac{9!}{2(4!)}$

53. The rank of the matrix $\begin{pmatrix} 1 & -1 & i \\ -1 & i & 1 \\ i & 1 & -1 \end{pmatrix}$ is

(A) 0
(B) 1
(C) 2
(D) 3

54. The value of $\begin{vmatrix} \cos 10^\circ & \sin 10^\circ \\ -\cos 50^\circ & \sin 50^\circ \end{vmatrix}$ is

(A) 0
(B) $\frac{1}{2}$
(C) $\frac{\sqrt{3}}{2}$
(D) 1

55. If A and B are square matrices of the same order, which one of the following is true?

(A) $|A+B| = |A| + |B|$
(B) $(AB)^{-1} = A^{-1}B^{-1}$
(C) $(AB)' = A'B'$
(D) $|AB| = |A||B|$

56. The least positive integer n such that $n!$ is divisible by 75 is

(A) 5
(B) 10
(C) 25
(D) 75

57. The roots of the equation $x^2 - cx + c = 0$ $(c \neq 0)$ are α and β. The real value of c for which $\alpha^2 + \beta^2$ is minimum is given by

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

58. The number of terms in the expansion of $\left[(1+x)^2(1-x)^2\right]^2$ is

(A) 5 (B) 10
(C) 2 (D) 4

59. A rectangular field is half as wide as it is long and the perimeter of the field is p. The area of the field in terms of p is

(A) $\frac{p^2}{2}$ (B) $2p^2$
(C) $\frac{p^2}{18}$ (D) $\frac{2p^2}{9}$

60. Given that $\int_0^{\sqrt{3}} \frac{dx}{1+x^2} = 2\int_a^{\sqrt{3}} \frac{dx}{1+x^2}$, the value of a is

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

61. For any complex number z the minimum value of $|z| + |z-1|$ is

(A) 1 (B) 0
(C) $\frac{1}{2}$ (D) $\frac{3}{2}$

62. In which polygon, the number of sides is equal to the number of diagonals

(A) quadrilateral (B) Pentagon
(C) Hexagon (D) None of these

63. The number of solutions of the equation $|x|^2 - 3|x| + 2 = 0$ is

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

64. If m, n are two positive integers then $(m+n+1)(m-n)+(m+n+2)(m-n-1)$ is

(A) always even
(B) even only when m is even and n is odd
(C) always odd
(D) odd only when m is odd and n is even

65. A regular hexagon is inscribed in a circle of diameter 'd'. Then the perimeter of the hexagon is

(A) $3d$ (B) $6d$
(C) $\frac{3\pi}{d}$ (D) $2d$

66. The derivative w.r.t. x of the product $(1+x)(1+x^2)(1+x^4)(1+x^8)...(1+x^{256})$ at $x=0$ is

(A) 0 (B) 1
(C) 8 (D) 9

67. n^3-n is divisible by

(A) 2 (B) 4
(C) 5 (D) 6

68. The smallest positive integer n for which n^2+n+17 is composite is

(A) 5 (B) 11
(C) 17 (D) 19

69. 220 cannot be the sum of first n cubes for a suitable n, because 220 is not

(A) an odd number (B) a perfect square
(C) a cube (D) a prime

70. The value of $\int_{-a}^{a}|x|\,dx$ is equal to

(A) a (B) a^2
(C) 0 (D) $2a$

71. The value of the product $\left(1-\frac{1}{2}\right)\left(1-\frac{1}{3}\right)\left(1-\frac{1}{4}\right)\left(1-\frac{1}{5}\right)\ldots\left(1-\frac{1}{n}\right)$ is

(A) n (B) $\frac{1}{n}$

(C) $\frac{2}{n}$ (D) $\frac{n}{2}$

72. If the ratio $\frac{z-i}{z+i}$ is purely imaginary, the point z lies on

(A) a circle (B) a parabola

(C) a hyperbola (D) an ellipse

73. Which one of the following is true for all positive integers?

(A) $n^n > 2^n.n!$ (B) $n^n > 2^n$

(C) $(n+1)^n > 2^n.n!$ (D) $2^n.n! > (n+1)^n$

74. Which one of the following equations cannot have any integral solutions?

(A) $6x+4y=91$ (B) $3x+2y=6$

(C) $8x-10y=42$ (D) $5x+7y=100$

75. The probability distribution of X is

x	0	1	2	3	4	5	6
p(x)	a	$2a$	$3a$	$4a$	$5a$	$6a$	$7a$

Then $P(X<6)$ is

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

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

76. The mapping $f: R_0 \to R_0$ where R_0 is the set of non-zero real numbers, defined by $f(x) = 1/x$, is

(A) one-one onto (B) one-one into

(C) many-one into (D) many-one onto

77. The function $f : R \to R$ is defined by $f(x) = \frac{x}{1-2x}, x \neq 1/2$. Then f^{-1} is given by

(A) $f^{-1}(x) = \frac{1-2x}{x}, x \neq 0$ (B) $f^{-1}(x) = \frac{1+2x}{x}, x \neq 0$

(C) $f^{-1}(x) = \frac{x}{1-2x}, x \neq 1/2$ (D) $f^{-1}(x) = \frac{x}{1+2x}, x \neq -1/2$

78. If $f(x) = \begin{cases} x \sin(1/x), & x \neq 0 \\ 0, & x = 0 \end{cases}$ then $\lim_{x \to 0} f(x)$ equals

(A) 1 (B) 0

(C) −1 (D) none of these

79. If $g[f(x)] = |\sin x|$ and $f[g(x)] = (\sin\sqrt{x})^2$, then

(A) $f(x) = \sin^2 x,\ g(x) = \sqrt{x}$ (B) $f(x) = \sin x,\ g(x) = |x|$

(C) $f(x) = x^2,\ g(x) = \sin\sqrt{x}$ (D) f and g cannot be determined

80. Let $f(x) = \frac{\alpha x}{1+x}, x \neq -1$. Then for what value of α is $f(f(x)) = x$?

(A) $\sqrt{2}$ (B) $-\sqrt{2}$

(C) 1 (D) -1

81. When $|\sin x| + |\cos x| \geq 1$, x has values between

(A) $[n\pi - \pi/4,\ n\pi], n \in N$ (B) all real positive values

(C) $[n\pi,\ n\pi + \pi/4], n \in N$ (D) all real values

82. For $k \in N$, $\lim_{n \to \infty} \log_{(n-1)}(n).\log_n(n+1)\ldots\log_{(n^k-1)}(n^k)$ is equal to

(A) $(k-1)$ (B) k

(C) $k+1$ (D) none of these

83. If $f(x)=\frac{2-\sqrt{x+4}}{\sin(2x)}$, $x\neq 0$ is continuous at $x=0$, then $f(0)$ is equal to

(A) $\frac{1}{4}$
(B) $-\frac{1}{4}$
(C) $\frac{1}{8}$
(D) $-\frac{1}{8}$

84. The value of the derivative of $|x-1|+|x+3|$ at $x=2$ is

(A) -2
(B) 0
(C) 2
(D) not defined

85. Let f and g be differentiable functions satisfying $g'(a)=2$, $g(a)=b$ and $f\circ g=I$ (Identity function). Then $f'(b)$ is equal to

(A) 2
(B) $\frac{2}{3}$
(C) $\frac{1}{2}$
(D) none of these

86. The locus of point z satisfying the condition $\arg\left(\frac{z-1}{z+1}\right)=\frac{\pi}{3}$ is

(A) straight line
(B) circle
(C) parabola
(D) hyperbola

87. The inequality $|z-4|<|z-2|$ represents the region given by

(A) $\text{Re}(z)>0$
(B) $\text{Re}(z)<0$
(C) $\text{Re}(z)>2$
(D) $\text{Re}(z)>3$

88. The value of the sum $\sum_{n=1}^{13}\left(i^n+i^{n+1}\right)$, $i=\sqrt{-1}$, equals

(A) i
(B) $i-1$
(C) $-i$
(D) 0

89. If $2+i\sqrt{3}$ is a root of the equation $x^2+px+q=0$ where p and q are real, then the values of p and q are

(A) $(4,-7)$
(B) $(4,7)$
(C) $(7,4)$
(D) $(-4,7)$

90. If the roots of the equation $ax^2+bx+c=0$ be α and β then the roots of the equation $cx^2+bx+a=0$ are

(A) $-\alpha, -\beta$ (B) $\alpha, \frac{1}{\beta}$

(C) $\frac{1}{\alpha}, \frac{1}{\beta}$ (D) none of these

91. If $f(x)=\cos^2 x+\sec^2 x$, then

(A) $f(x)>1$ (B) $f(x)=1$

(C) $2>f(x)>1$ (D) $f(x)\geq 2$

92. If $\tan\theta+\sin\theta=m$ and $\tan\theta-\sin\theta=n$, then

(A) $m^2-n^2=4mn$ (B) $m^2+n^2=4mn$

(C) $m^2+n^2=m^2-n^2$ (D) $m^2-n^2=4\sqrt{(mn)}$

93. If $\tan\alpha=\frac{m}{m+1}$, $\tan\beta=\frac{1}{2m+1}$, then $\alpha+\beta$ is equal to

(A) $\pi/2$ (B) $\pi/3$

(C) $\pi/6$ (D) $\pi/4$

94. Which of the following number(s) is/are rational(s) ?

(A) $\sin(15^\circ)$ (B) $\cos(15^\circ)$

(C) $\sin(15^\circ)\cos(15^\circ)$ (D) $\sin(15^\circ)\cos(75^\circ)$

95. $\left(\frac{1-\sin\theta}{1+\sin\theta}\right)^{1/2}$ is equal to

(A) 0 (B) 1

(C) $\sec\theta\tan\theta$ (D) $\sec\theta-\tan\theta$

96. The number of diagonals in a polygon of n sides is

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

(C) $\frac{n}{2}(n-3)$ (D) $\frac{1}{2}n(n-2)$

97. The fourth, seventh and tenth terms of a $G.P$ are p,q,r respectively. Then

(A) $p^2 = q^2 + r^2$ (B) $q^2 = pr$
(C) $p^2 = qr$ (D) $pqr + pq + 1 = 0$

98. Sum of the n terms of the series 12 + 16 + 24 + 40 + … will be

(A) $2(2^n - 1) + 8n$ (B) $2(2^n - 1) + 6n$
(C) $3(2^n - 1) + 8n$ (D) $4(2^n - 1) + 8n$

99. If H is the harmonic mean between P and Q, then $\frac{H}{P} + \frac{H}{Q}$ is equal to

(A) 2 (B) $\frac{PQ}{P+Q}$
(C) $\frac{P+Q}{PQ}$ (D) none of these

100. If $a^{1/x} = b^{1/y} = c^{1/z}$ and a,b,c are in $G.P.$, then x, y, z are in

(A) $A.P.$ (B) $G.P.$
(C) $H.P.$ (D) none of these

101. If $\frac{dy}{dx} = \infty$ at a point P on the curve $y = f(x)$, then

(A) the normal at P to the curve $y = f(x)$ is parallel to x-axis
(B) the normal at P to the curve $y = f(x)$ is parallel to y-axis
(C) the tangent at P to the curve $y = f(x)$ is parallel to x-axis
(D) the tangent at P to the curve $y = f(x)$ is parallel to y-axis

102. The slope of the tangent to the curve $y = \tan^{-1}(x) + \tan^{-1}(1/x)$ at a general point is

(A) $-1/x^2$ (B) 0
(C) 1 (D) x

103. The curves $y^2 = x$ and $x^2 = 4y$ intersect each other at

(A) only one point (B) two points
(C) three points (D) four points

104. The function $(1-\cos x)$ is increasing when x lies in

(A) $(-\pi, 0)$ (B) $(0, \pi)$
(C) $(-\infty, 0)$ (D) $(0, \infty)$

105. The curve $(y-5)^2 = 12(x-3)$ is symmetrical about the line

(A) $x = 0$ (B) $x - 3 = 0$
(C) $y = 0$ (D) $y - 5 = 0$

106. The equation of the ellipse, whose foci are at $(\pm 4, 0)$ and eccentricity is $\frac{1}{3}$, is

(A) $\frac{x^2}{128} + \frac{y^2}{144} = 1$ (B) $\frac{x^2}{144} + \frac{y^2}{128} = 1$
(C) $\frac{x^2}{96} + \frac{y^2}{144} = 1$ (D) $\frac{x^2}{144} + \frac{y^2}{96} = 1$

107. If $x + iy = \sqrt{\frac{a+ib}{c+id}}$, then $(x^2+y^2)^2$ is

(A) $\frac{a+b}{c+d}$ (B) $\frac{a^2-b^2}{c^2-d^2}$
(C) $\frac{a^2+b^2}{c^2-d^2}$ (D) $\frac{a^2+b^2}{c^2+d^2}$

108. When a complex number is multiplied by (-1), its argument

(A) gets decreased by 90^o (B) gets divided by 90^o
(C) gets increased by 90^o (D) gets multiplied by 90^o

109. The least value of n, for which $\left[(1+i)/(1-i)\right]^n = 1$, is

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

110. If α and β are the roots of $x^2 - 2x + 4 = 0$, then $\alpha^n + \beta^n$ is

(A) $2^n \cos\frac{2n\pi}{3}$ (B) $2^n \cos\frac{n\pi}{3}$
(C) $2^{n+1} \cos\frac{n\pi}{3}$ (D) $2^n \cos\frac{n\pi}{4}$

111. Given $\vec{A}, \vec{B}, \vec{C}$ are three non-zero, non-coplanar vectors and m, n, p are three scalars such that $m\vec{A} + n\vec{B} + p\vec{C} = 0$, then

(A) $m = n = p = 0$
(B) $m + n + p = 0$
(C) $\frac{m}{n} = \frac{n}{p}$
(D) $m + p = 2n$

112. Given $\vec{a} = \vec{i} + \vec{j} - \vec{k}$, $\vec{b} = -\vec{i} + 2\vec{j} + \vec{k}$ and $\vec{c} = -\vec{i} + 2\vec{j} - \vec{k}$, a unit vector perpendicular to both $\vec{a} + \vec{b}$ and $\vec{b} + \vec{c}$ is

(A) $\vec{i}$
(B) $\vec{j}$
(C) $\vec{k}$
(D) $\frac{\vec{i} + \vec{j} + \vec{k}}{\sqrt{3}}$

113. Any vector can be expressed in terms of

(A) any three given vectors
(B) any three non-coplanar vectors
(C) any triad
(D) three coplanar vectors

114. The angle between the planes $4x - 6y + 2z = 3$ and $6x + 5y + 3z = 6$ is

(A) 0
(B) $\frac{\pi}{4}$
(C) $\frac{\pi}{3}$
(D) $\frac{\pi}{2}$

115. The area between the curve $y = x^2$ and the lines $x = 0$ and $y = 4$ is

(A) $\frac{32}{3}$
(B) $\frac{16}{3}$
(C) $\frac{8}{3}$
(D) $\frac{2}{3}$

116. $y = ae^x - be^{-x}$ is a solution of the differential equation

(A) $y'' = y'$
(B) $y'' + y' + y = 0$
(C) $y'' - y = 0$
(D) $y'' - aby = 0$

117. The differential equation of all circles, which pass through the origin and whose centres are on the x – axis, is

(A) $x^2 + y^2 + 2gx + c = 0$ (B) $y^2 - x^2 + 2xyy' = 0$

(C) $y^2 - x^2 - 2xyy' = 0$ (D) $-y^2 + x^2 - 2xyy' = 0$

118. The differential equation formed by eliminating a and b from $y = (a + bx)e^{-x}$ is

(A) $y_2 + 2y_1 + y = 0$ (B) $y_2 - 2y_1 + y = 0$

(C) $y_2 + 2y_1 + 2y = 0$ (D) $y_2 - 2y_1 = 0$

119. With respect to multiplication, the set $\{0, 1, -1\}$ does NOT form a group, since it fails to satisfy

(A) associativity (B) closure

(C) existence of identity (D) existence of inverse

120. Which of the following is true?

(A) Division is a binary operation in Z

(B) Division is a binary operation in N

(C) Division is a binary operation in $R - \{0\}$

(D) Division is a binary operation in R

121. In the group $\{(1, -1, i, -i), \times\}$ the order of the element $-i$, is

(A) 8 (B) 2

(C) 4 (D) 6

122. If $\omega = \cos\frac{2k\pi}{n} + i\sin\frac{2k\pi}{n}$ and $G = \{1, \omega, \omega^2, ..., \omega^n\}$, then G with multiplication as a binary operation is

(A) a monoid (B) a non abelian group

(C) a semi group (D) an abelian group

123. Given $f_1(x) = x$, $f_2(x) = -x$, $f_3(x) = \frac{1}{x}$ and $f_4(x) = -\frac{1}{x}$ and $\circ$ stands for composition of function, then $(f_4 \circ f_2)(x)$ is

(A) $f_1(x)$ (B) $f_2(x)$

(C) $f_3(x)$ (D) $f_4(x)$

124. Which statement is true, given H is a sub group of G ?

(A) $a, b \in H$ need not imply $a * b^{-1} \in H$
(B) Identity element of H is not same as that of G
(C) Identity element of H need not belong to G
(D) Inverse of $a \in H$ is same as the inverse of $a \in G$

125. $G = \{8^n \mid n \in Z\}$ is cyclic. The generators of Z are

(A) 2 and $\frac{1}{2}$
(B) 4 and $\frac{1}{4}$
(C) 6 and $\frac{1}{6}$
(D) 8 and $\frac{1}{8}$

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