1. If A is a square matrix and $A^T$, $A^0$ are respectively the transpose and transposed conjugate of matrix A, then which is not correct?
   (A) $A + A^T$ is symmetric
   (B) $A + A^0$ is Hermitian
   (C) $A - A^T$ is skew-symmetric
   (D) $A - A^0$ is Hermitian

2. The rank of the matrix 
\[
\begin{pmatrix}
2 & -3 & 4 \\
-1 & -1 & 1 \\
4 & -1 & 2
\end{pmatrix}
\] is:
   (A) 1                  (B) 2
   (C) 3                  (D) None of these

3. The characteristic equation of the matrix 
\[
A = \begin{pmatrix}
-2 & 5 \\
1 & 2
\end{pmatrix}
\] is:
   (A) $\lambda^2 + 4 = 0$                  (B) $\lambda^2 + 6 = 0$
   (C) $\lambda^2 - 9 = 0$                  (D) $\lambda^2 - 5 = 0$

4. Consider the matrix 
\[
A = \begin{pmatrix}
8 & -6 & 2 \\
-6 & 7 & -4 \\
2 & -4 & 3
\end{pmatrix}
\], then:
   (A) A has no real eigen values.
   (B) All real eigen values of A are positive.
   (C) All real eigen values of A are negative.
   (D) A has both positive and negative real eigen values.
5. The system of equations \(2x - 3y + z = 9; \ x + y + z = 6; \ x - y + z = 2\) has:
(A) a unique solution (B) infinite solutions
(C) no solution (D) none of these

6. What is the remainder when \(2x^3 - 6x + 23\) is divided by \(x - 2\)?
(A) 13 (B) 18
(C) 27 (D) 35

7. If the roots of the equation \(4x^3 + 12x^2 + 11x + 3 = 0\) are in A.P., then roots are:
(A) \(-\frac{3}{2}, -1, -\frac{1}{2}\) (B) \(\frac{1}{4}, \frac{1}{2}, \frac{3}{4}\)
(C) 1, 2, 4 (D) 1, 4, 7

8. The transformed equation whose roots are two times the roots of the equation \(3x^4 - 2x^2 + 5 = 0\), is:
(A) \(x^4 - 4x^2 + 80 = 0\) (B) \(3x^4 - 8x^2 + 80 = 0\)
(C) \(3x^4 - 4x^2 + 16 = 0\) (D) None of these

9. The equation \(2x^7 - 5x^4 + 3x^3 - 1 = 0\) has:
(A) all real roots
(B) at least six imaginary roots
(C) at least four imaginary roots
(D) None of the above

10. If \(f: \mathbb{R} \rightarrow \mathbb{R}\) be a function on \(\mathbb{R}\) defined by \(f(x) = x^2 + 8x + 3\), then \(f^{-1}(-12)\) is:
(A) \(\{5, 3\}\) (B) \(\{-5, 3\}\)
(C) \(\{5, -3\}\) (D) \(\{-5, -3\}\)
11. Let \( A = \{1, 2, 3, 4\} \) and \( R = \{(1, 1), (1, 2), (2, 2), (2, 3), (3, 3), (4, 4)\} \) be the relation defined on \( A \), then the relation \( R \) is:
(A) reflexive, symmetric and transitive
(B) reflexive but not symmetric and not transitive
(C) reflexive, symmetric but not transitive
(D) None of the above

12. What is the least positive integer (mod 11) to which 282 is congruent?
(A) 5  (B) 7  
(C) 13  (D) None of these

13. Which one of the following is false?
(A) The set of all odd integers is not a group with respect to addition.
(B) The set of all even integers including zero is an abelian group with respect to addition.
(C) The set of complex numbers is not an abelian group with respect to addition.
(D) The set of all \( 2 \times 2 \) matrices form an abelian group with respect to matrix addition.

14. Let \( G = \{1, 2, 3, 4, 5, 6\} \) be a group under the binary operation ‘multiplication modulo 7’, then the order of element 3, is:
(A) 1  (B) 2
(C) 3  (D) 6

15. The number of generators of the cyclic group \( G \) of order 10 are:
(A) 4  (B) 2
(C) 1  (D) None of these
16. Let \( f = (1 \ 2 \ 3) \) and \( g = (4 \ 5) \) be two cyclic permutations defined on set \( S = \{1, 2, 3, 4, 5\} \), then composition \( (g \circ f) \) of \( g \) and \( f \) is given by:

(A) \[
\begin{pmatrix}
1 & 2 & 3 & 4 & 5 \\
2 & 3 & 1 & 4 & 5 \\
\end{pmatrix}
\]

(B) \[
\begin{pmatrix}
1 & 2 & 3 & 4 & 5 \\
2 & 3 & 5 & 1 & 4 \\
\end{pmatrix}
\]

(C) \[
\begin{pmatrix}
1 & 2 & 3 & 4 & 5 \\
2 & 3 & 1 & 5 & 4 \\
\end{pmatrix}
\]

(D) None of these

17. If the mapping \( f : \mathbb{C} \to \mathbb{R} \) defined by \( f(x + iy) = x \) is a homomorphism of the additive group of complex numbers onto the additive group of real numbers, then kernel of \( f \) is:

(A) The set of all complex numbers with real part zero.

(B) The set of all complex numbers with real part non-zero and imaginary part zero.

(C) The set of all complex numbers with real part non-zero and imaginary part non-zero.

(D) None of the above

18. The centre of a non-abelian group of order 125 has elements in its centre.

(A) 3  

(B) 5  

(C) 7  

(D) None of these

19. Let \( R \) be a ring of \( 2 \times 2 \) matrices over integers. Consider

\[
S = \begin{bmatrix}
a & b \\
0 & 0 \\
\end{bmatrix} ; \quad a, b \in \mathbb{Z}
\]

Then which of the following is true?

(A) \( S \) is neither a left ideal nor a right ideal.

(B) \( S \) is a left ideal but not a right ideal.

(C) \( S \) is a right ideal but not a left ideal.

(D) None of the above
20. Let \( f(x) \) and \( g(x) \) be two non-zero polynomials of \( \mathbb{R}[x] \), then which of the following is false?

(A) \( \deg [f(x) + g(x)] \leq \max \{\deg f(x), \deg g(x)\} \)

(B) \( \deg [f(x) \cdot g(x)] \leq \deg f(x) + \deg g(x) \)

(C) \( \deg [f(x) + g(x)] > \max \{\deg f(x), \deg g(x)\} \)

(D) None of the above

21. Let \( V \) be a vector space over \( \mathbb{R}^3 \). Which one of the following is not a subspace of \( V \)?

(A) \( \{(x, y, z) : x \geq y \geq z, x, y, z \in \mathbb{R}\} \)

(B) \( \{(x, y, z) : x = y = z, x, y, z \in \mathbb{R}\} \)

(C) \( \{(x, y, z) : y + 4z = 0, x, y, z \in \mathbb{R}\} \)

(D) None of the above

22. The dimension of the subspace \( W \) of \( \mathbb{R}^4 \) generated by \( \{(1, 4, -1,3), (2,1, -3, -1), (0, 2, 1, -5)\} \) is:

(A) 1

(B) 2

(C) 3

(D) None of these

23. Which of the following is a linear transformation?

(A) \( T(x, y) = (1 + x, y) \) for all \( (x, y) \in \mathbb{R}^2 \)

(B) \( T(x, y) = (x, x + y) \) for all \( (x, y) \in \mathbb{R}^2 \)

(C) \( T(x, y) = (x^2, y) \) for all \( (x, y) \in \mathbb{R}^2 \)

(D) None of the above
24. Let $V$ be the vector space of $2 \times 2$ matrices over $\mathbb{R}$ and let $M = \begin{bmatrix} 1 & -1 \\ -2 & 2 \end{bmatrix}$.

Let $T : V \to V$ be the linear transformation defined by $T(A) = MA$ for all $A \in V$. Then dimension of null space of $T$ is :

(A) 1  
(B) 2  
(C) 3  
(D) None of these

25. The symmetric matrix of the quadratic form $x^2 - 2y^2 + 3z^2 - 4yz + 6zx$ is :

(A) $\begin{bmatrix} 1 & 0 & 3 \\ 0 & 2 & 2 \\ 3 & 2 & 3 \end{bmatrix}$  
(B) $\begin{bmatrix} 1 & 0 & -3 \\ 0 & -2 & -2 \\ -3 & -2 & -3 \end{bmatrix}$  
(C) $\begin{bmatrix} 1 & 0 & 3 \\ 0 & -2 & -2 \\ 3 & -2 & 3 \end{bmatrix}$  
(D) None of these

26. The norm of the vector $(1, -2, 5)$ is :

(A) $\sqrt{30}$  
(B) $\sqrt{20}$  
(C) $\sqrt{10}$  
(D) None of these

27. If $y = \frac{\log x}{x}$, then $\frac{d^2 y}{dx^2}$ is equal to :

(A) $\frac{\log x - 3}{x^2}$  
(B) $\frac{2 \log x - 3}{x^3}$  
(C) $\frac{2 \log x + 1}{x^3}$  
(D) None of these
28. The $n$th derivative of $\frac{3x+5}{x+2}$ is:

(A) $(-1)^{n-1}n! \frac{1}{(x+2)^n}; n \geq 1$

(B) $(-1)^{n+1}n! \frac{1}{(x+2)^{n+1}}; n \geq 1$

(C) $(-1)^n n! \frac{1}{(x+2)^{n-1}}; n \geq 1$

(D) None of these

29. The asymptote of the curve $xy^2 + 4a^2x - 8a^3 = 0$ is:

(A) $x + y = 0$

(B) $x - y = 0$

(C) $x = 0$

(D) None of these

30. The radius of curvature of the curve $y = e^x$ at the point where it crosses the $y$-axis, is given by:

(A) $2\sqrt{2}$

(B) $\frac{2\sqrt{2}}{3}$

(C) $\sqrt{2}$

(D) None of these

31. The sequence $<\frac{n!}{n^n}>$ converges to the limit:

(A) $e$

(B) 2

(C) 1

(D) 0

32. The series $\frac{1!}{5} + \frac{2!}{5^2} + \frac{3!}{5^3} + \ldots$ is:

(A) Convergent

(B) Divergent

(C) Oscillatory

(D) None of these
33. Consider the statements :

(a) The series \( 1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \ldots \) is convergent.

(b) The series \( 1 - \frac{1}{3!} + \frac{1}{5!} - \frac{1}{7!} + \ldots \) is convergent.

Then :
(A) both the statements (a) and (b) are true
(B) the statement (a) is true and (b) is false
(C) the statement (a) is false and (b) is true
(D) neither (a) nor (b) is true

34. If \( f \) is a continuous function of \( \mathbb{R} \), then which of the following is a closed set ?

(A) the set \( \{ x \in \mathbb{R} : f(x) > 0 \} \)
(B) the set \( \{ x \in \mathbb{R} : f(x) < 0 \} \)
(C) the set \( \{ x \in \mathbb{R} : f(x) = 0 \} \)
(D) None of the above

35. Lagrange’s mean value theorem is not applicable to the function :

(A) \( f(x) = 2x^2 - 3x + 1 \) in \([1,3]\)
(B) \( f(x) = x^2 + x - 1 \) in \([0,4]\)
(C) \( f(x) = x^3 - 2x \) in \([-1,1]\)
(D) \( f(x) = |x| \) in \([-1,1]\)

36. If \( u = \cos^{-1}\left(\frac{x+y}{\sqrt{x+y}}\right) \), then \( x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} \) is equal to :

(A) \( -\frac{1}{2} \tan u \)
(B) \( -\frac{1}{2} \sin u \)
(C) \( -\frac{1}{2} \cot u \)
(D) None of these
37. The function \( f(x, y) = 3x^2 - y^2 + x^3 \) has a maximum value at the extreme point:

(A) (0, 3)  
(B) (0, 0)  
(C) (–3, 0)  
(D) (–2, 0)

38. The value of \( \lim_{x \to 0} \left( \frac{\cosh x - \cos x}{x \sin x} \right) \) is:

(A) 3  
(B) 1  
(C) 0  
(D) None of these

39. The value of integral \( \int_0^\infty \sqrt{x} e^{-x^3} \, dx \) is equal to:

(A) \( \Gamma \left( \frac{1}{2} \right) \)  
(B) \( \frac{1}{3} \Gamma \left( \frac{1}{2} \right) \)  
(C) \( \frac{1}{2} \Gamma \left( \frac{1}{2} \right) \)  
(D) None of these

40. The value of integral \( \int_0^1 \int_0^3 x^2 \, dy \, dx \) is:

(A) 27/4  
(B) 11/5  
(C) 8/3  
(D) None of these

41. The Dirichlet integral \( \iiint_V x^{p-1} y^{m-1} z^{n-1} \, dx \, dy \, dz \), where \( V \) is the region \( x \geq 0, y \geq 0, z \geq 0 \) and \( x + y + z \leq 1 \), is equal to:

(A) \( \frac{\Gamma(p) \Gamma(m) \Gamma(n)}{\Gamma(p + m + n)} \)  
(B) \( \frac{\Gamma(p) \Gamma(m) \Gamma(n)}{2 \Gamma(p + m + n)} \)  
(C) \( \frac{\Gamma(p) \Gamma(m) \Gamma(n)}{\Gamma(1 + p + m + n)} \)  
(D) None of these
42. If \( f(x) = x \), \( x \in [0, 1] \) and let \( P = \left\{ 0, \frac{1}{3}, \frac{1}{2}, \frac{2}{3}, 1 \right\} \) be the partition of \([0, 1]\), then \( L(f, P) \) is:

(A) \( \frac{49}{36} \)  
(B) \( \frac{31}{36} \)  
(C) \( \frac{23}{36} \)  
(D) \( \frac{13}{36} \)

43. The integral \( \int_{-\infty}^{\infty} \frac{1}{1 + x^2} \, dx \) is:

(A) a proper integral  
(B) an improper integral of first kind  
(C) an improper integral of second kind  
(D) an improper integral of third kind

44. The improper integral \( \int_{0}^{1} \frac{1}{\sqrt{1-x}} \, dx \) converges to:

(A) 2  
(B) 1  
(C) 0  
(D) None of these

45. If \( \sum_{n=1}^{\infty} a_n \) is convergent and the sequence \( < b_n > \) is monotonic and bounded, then \( \sum_{n=1}^{\infty} a_n b_n \) is convergent. This statement refers to:

(A) Cauchy’s theorem  
(B) Dirichlet’s test  
(C) Abel’s test  
(D) None of these
46. The Fourier coefficient $a_0$ for the function $f(x) = x^2$ in $[-\pi, \pi]$ is:

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

47. If $f_x$ and $f_y$ are both differentiable at a point $(a, b)$ of the domain of definition of the function $f$, then $f_{xy} = f_{yx}$. This result is known as:

(A) Implicit function theorem  
(B) Schwarz’s theorem  
(C) Young’s theorem  
(D) None of these

48. If $v = e^x (x \sin y + y \cos y)$ is the imaginary part of an analytic function $f(z)$, then:

(A) $f(z) = e^z + c$  
(B) $f(z) = ze^z + c$  
(C) $f(z) = ze^{-z} + c$  
(D) None of these

49. The fixed points of the Mobius transformation $w = \frac{z + 2}{4 - z}$ are:

(A) 1, 2  
(B) 0, -1  
(C) 0, 2  
(D) None of these

50. Which of the following is not a complete metric space?

(A) The metric space $(0, 1]$ with usual metric $d(x, y) = |x - y|$  
(B) A trivial metric space  
(C) The usual metric space $(\mathbb{R}, d)$  
(D) The space of complex numbers
51. Baire’s Category theorem states that:

(A) A continuous image of a connected space is connected.
(B) Every closed subset of a compact metric space is compact.
(C) Every complete metric space is of the second category as a subset of itself.
(D) None of the above

52. Let \((R, d)\) be a metric space, where \(d\) is a usual metric. Then \((R, d)\) is a:

(A) compact metric space but not connected
(B) connected metric space but not compact
(C) connected as well as compact metric space
(D) None of the above

53. Consider the differential equation \((x-1)(x+2)\frac{d^2 y}{dx^2} + x^2 \frac{dy}{dx} + xy = 0\). Then:

(A) Both \(-2\) and \(1\) are not singular points.
(B) Both \(-2\) and \(1\) are regular singular points.
(C) \(-2\) is a regular singular point and \(1\) is an irregular singular point.
(D) \(-2\) is an irregular singular point and \(1\) is a regular singular point.

54. Which of the following is *not* an exact differential equation?

(A) \([\cos x \tan y + \cos(x+y)]dx + [\sin x \sec^2 y + \cos(x+y)]dy = 0\)
(B) \((x^2 - 2xy + 3y^2)dx + (4y^3 + 6xy - x^2)dy = 0\)
(C) \(x(1 + y^2)dx + y(1 + x^2)dy = 0\)
(D) \(x^2y dx - (x^3 + y^3)dy = 0\)
55. The solution of the differential equation \( \frac{d^2 y}{dx^2} - 5 \frac{dy}{dx} + 6y = 0 \) is given by:

(A) \( y = c_1 e^{2x} + c_2 e^{-3x} \), where \( c_1 \) and \( c_2 \) are constants

(B) \( y = c_1 e^{2x} + c_2 e^{3x} \), where \( c_1 \) and \( c_2 \) are constants

(C) \( y = c_1 e^{-2x} + c_2 e^{3x} \), where \( c_1 \) and \( c_2 \) are constants

(D) None of the above

56. The particular integral of the differential equation \( \frac{d^2 y}{dx^2} - 4y = e^{x} + \sin 2x \), is given by:

(A) \( -\frac{1}{3}e^{x} - \frac{1}{8} \sin 2x \)

(B) \( \frac{1}{3}e^{x} + \frac{1}{8} \sin 2x \)

(C) \( \frac{1}{3}e^{x} - \frac{1}{8} \sin 2x \)

(D) None of these

57. The value of Bessel’s function \( J_{3/2}(x) \) is given by:

(A) \( \sqrt{\frac{2}{\pi x}} \left( \frac{\sin x}{x} - \cos x \right) \)

(B) \( \sqrt{\frac{2}{\pi x}} \cos x \)

(C) \( \sqrt{\frac{\pi x}{2}} \sin x \)

(D) \( \sqrt{\frac{2}{\pi x}} \left( \frac{\sin x}{x} + \cos x \right) \)

58. Which of the following is true about Legendre’s polynomials?

(A) \( P_1(x) = x \)

(B) \( P_2(x) = \frac{1}{2}(3x^2 - 1) \)

(C) \( P_3(x) = \frac{1}{2}(5x^3 - 3x) \)

(D) All of these
59. The first derivative of the Hypergeometric function $F(\alpha, \beta, \gamma, x)$ w.r.t. $x$, is:

(A) $\frac{\alpha\beta}{\gamma} F(\alpha-1, \beta-1, \gamma-1, x)$
(B) $\alpha\beta\gamma F(\alpha+1, \beta+1, \gamma+1, x)$
(C) $\frac{\alpha\beta}{\gamma} F(\alpha+1, \beta+1, \gamma+1, x)$
(D) None of these

60. The Laplace transform of $f(t) = t^2 \sin 4t$ is:

(A) $\frac{4(3s^2+16)}{(s^2+16)^3}$
(B) $\frac{8(3s^2-16)}{(s^2+16)^3}$
(C) $\frac{2(s^2-16)}{(s^2+16)^3}$
(D) None of these

61. The inverse Laplace transform of $\frac{s}{(s+a)^2}$ is:

(A) $e^{at} [1- at]$ 
(B) $e^{-at} [1+ at]$ 
(C) $e^{at} [1+ at]$ 
(D) $e^{-at} [1- at]$ 

62. If $F(s)$ is the Fourier transform of $f(t)$, then $\frac{d^n}{ds^n} F(s)$ is:

(A) $(-i)^n F[t^n f(t)]$ 
(B) $i^n F[t^n f(t)]$ 
(C) $(-1)^n F[t^n f(t)]$ 
(D) None of these

63. The complete integral of partial differential equation $yz p^2 - q = 0$ is:

(A) $z (a-y^2) = (x-b)^2$, where $a$ and $b$ are constants 
(B) $z^2 (a+y) = (x+b)^2$, where $a$ and $b$ are constants 
(C) $z^2 (a-y^2) = (x+b)^2$, where $a$ and $b$ are constants 
(D) None of the above
64. The particular integral of the differential equation \((D^2 + 3DD' + 2D')z = 2x + 3y\) is given by:

(A) \(\frac{1}{150} (2x + 3y)^3\)  
(B) \(\frac{1}{240} (2x + 3y)^3\)

(C) \(\frac{1}{320} (2x + 3y)^3\)  
(D) None of these

65. The solution of the differential equation \((D^2 - DD' - 2D)z = e^{2x+y}\) is:

(A) \(z = \phi_1(y) + e^{2x} \phi_2(x) + \frac{1}{2} e^{2x+y}\)

(B) \(z = e^x \phi_1(y + x) + e^{2x} \phi_2(y + x) + \frac{1}{3} e^{2x+y}\)

(C) \(z = e^{-x} \phi_1(y - x) + \phi_2(y + x) - \frac{1}{6} e^{2x+y}\)

(D) None of the above

66. The conic \(2x^2 + 4xy + 3y^2 - 8x - 14y + 9 = 0\) represents:

(A) ellipse  
(B) parabola

(C) hyperbola  
(D) circle

67. The pole of the plane \(lx + my + nz = p\), w.r.t. the conicoid \(ax^2 + by^2 + cz^2 = 1\), is:

(A) \(\begin{pmatrix} l \\ m \\ n \end{pmatrix} \begin{pmatrix} p \\ p \\ p \end{pmatrix}\)  
(B) \(\begin{pmatrix} l \\ m \\ n \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix}\)

(C) \(\begin{pmatrix} l^2 \\ m^2 \\ n^2 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} \begin{pmatrix} p \\ p \\ p \end{pmatrix}\)  
(D) \(\begin{pmatrix} l \\ m \\ n \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} \begin{pmatrix} p \\ p \\ p \end{pmatrix}\)
68. The equations to the generating lines of the hyperboloid \( \frac{x^2}{4} + \frac{y^2}{9} - \frac{z^2}{16} = 1 \) which pass through the point \( (2, 3, -4) \) are:

(A) \( \frac{x-2}{0} = \frac{y-3}{-3} = \frac{z+4}{4} \) and \( \frac{x-2}{1} = \frac{y-3}{0} = \frac{z+4}{2} \)

(B) \( \frac{x-2}{0} = \frac{y-3}{-3} = \frac{z+4}{-4} \) and \( \frac{x-2}{-1} = \frac{y-3}{0} = \frac{z+4}{2} \)

(C) \( \frac{x-2}{0} = \frac{y-3}{3} = \frac{z+4}{-4} \) and \( \frac{x-2}{1} = \frac{y-3}{0} = \frac{z+4}{-2} \)

(D) None of the above

69. The equation of the plane, which cuts the sphere \( x^2 + y^2 + z^2 = a^2 \) in a circle, whose centre is \( (\alpha, \beta, \gamma) \), is given by:

(A) \( \alpha (x-\alpha) + \beta (y-\beta) + \gamma (z-\gamma) = 0 \)

(B) \( \alpha (x+\alpha) + \beta (y+\beta) + \gamma (z+\gamma) = 0 \)

(C) \( (x-\alpha) + (y-\beta) + (z-\gamma) = 0 \)

(D) None of the above

70. If a right circular cone has three mutually perpendicular generators, then the semivertical angle of the cone is:

(A) \( \tan^{-1} \sqrt{3} \)

(B) \( \tan^{-1} \sqrt{2} \)

(C) \( \tan^{-1} \left( \frac{1}{\sqrt{3}} \right) \)

(D) None of the above
71. The equation of the right circular cylinder whose generators are parallel to the line \( \frac{x}{1} = \frac{y}{2} = \frac{z}{3} \) and passes through \( x^2 + y^2 = 16, z = 0 \), is given by:

(A) \( 9x^2 + 9y^2 + 5z^2 - 6xz - 12yz - 144 = 0 \)

(B) \( x^2 + 4y^2 + 9z^2 - xz - 12yz - 144 = 0 \)

(C) \( 9x^2 + 9y^2 + z^2 - 6xz - yz - 144 = 0 \)

(D) None of the above

72. Which is correct?

(A) \( \frac{d\vec{b}}{ds} = \tau \vec{n} \)

(B) \( \frac{d\vec{l}}{ds} = \kappa \vec{n} \)

(C) \( \frac{d\vec{n}}{ds} = \kappa \vec{t} - \tau \vec{b} \)

(D) None of the above

73. The curvature \( \kappa \) and torsion \( \tau \) of a curve are:

(A) \( \kappa = \frac{|\dot{\vec{r}} \times \ddot{\vec{r}}|}{|\dot{\vec{r}}|^3}, \quad \tau = \frac{[\dot{\vec{r}} \ \ddot{\vec{r}} \ \dddot{\vec{r}}]}{|\dot{\vec{r}} \times \ddot{\vec{r}}|^3} \)

(B) \( \kappa = \frac{|\dot{\vec{r}} \times \ddot{\vec{r}}|}{|\dot{\vec{r}}|^3}, \quad \tau = \frac{[\dot{\vec{r}} \ \ddot{\vec{r}} \ \dddot{\vec{r}}]}{|\dot{\vec{r}} \times \ddot{\vec{r}}|^3} \)

(C) \( \kappa = \frac{|\dot{\vec{r}} \times \ddot{\vec{r}}|}{|\dot{\vec{r}}|^3}, \quad \tau = \frac{[\dot{\vec{r}} \ \ddot{\vec{r}} \ \dddot{\vec{r}}]}{|\dot{\vec{r}} \times \ddot{\vec{r}}|^2} \)

(D) None of the above
74. Which is not correct?

(A) Two couples of equal and opposite moments in parallel planes balance each other.

(B) Two coplanar couples of equal and opposite moments balance each other.

(C) Two couples in the same plane of equal moments and acting in the opposite sense are equivalent.

(D) None of the above

75. A sphere of weight \( W \) and radius \( a \) lies within a fixed spherical shell of radius \( b \) and a particle of weight \( w \) is fixed to the upper end of the vertical diameter. Then the equilibrium is stable if:

(A) \( \frac{W}{w} < \frac{b - 2a}{a} \)

(B) \( \frac{W}{w} > \frac{b - 2a}{a} \)

(C) \( \frac{W}{w} > \frac{b - a}{2a} \)

(D) None of the above

76. The condition that the straight line \( \frac{x - f}{l} = \frac{y - g}{m} = \frac{z - h}{n} \) may be a null line for the system of forces \( (X, Y, Z; L, M, N) \) is:

(A) \( \begin{vmatrix} X & Y & Z \\ l & m & n \\ f & g & h \end{vmatrix} = lL + mM + nN \)

(B) \( \begin{vmatrix} x & y & z \\ f & g & h \\ X & Y & Z \end{vmatrix} = lL + mM + nN \)

(C) \( \begin{vmatrix} X & Y & Z \\ L & M & N \\ f & g & h \end{vmatrix} = lL + mM + nN \)

(D) None of these
77. If the radial and transverse velocities of a particle are proportional to each other, then the path is:

(A) equiangular spiral  (B) circle
(C) straight line  (D) None of these

78. A particle describes the cycloid \( s = 4a \sin \psi \) with uniform speed \( v \). Then its acceleration at any point is given by:

(A) \( \frac{v^2}{\sqrt{4a^2 - s^2}} \)  (B) \( \frac{v}{\sqrt{16a^2 - s^2}} \)
(C) \( \frac{v^2}{\sqrt{16a^2 - s^2}} \)  (D) None of these

79. The maximum velocity of a body moving with S.H.M. is 2 unit/sec. and its period is 0.2 sec. Then the amplitude is:

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

80. A particle slides down the arc of a smooth cycloid, whose axis is vertical and vertex downwards. Then the periodic time is given by:

(A) \( 2\pi \sqrt{\frac{g}{a}} \)  (B) \( 4\pi \sqrt{\frac{g}{a}} \)
(C) \( 2\pi \sqrt{\frac{a}{g}} \)  (D) \( 4\pi \sqrt{\frac{a}{g}} \)
81. The greatest and least velocities of a certain planet in its orbit round the sun are 30 km./sec. and 29.2 km./sec. respectively. Then the eccentricity of the orbit is:

(A) \( \frac{1}{58} \)  
(B) \( \frac{1}{74} \)  
(C) \( \frac{1}{27} \)  
(D) \( \frac{1}{60} \)

82. The value of \( \left( E^{1/2} + E^{-1/2} \right) (1+\Delta)^{1/2} \) is:

(A) \( \Delta + 1 \)  
(B) \( \Delta - 1 \)  
(C) \( \Delta + 2 \)  
(D) \( \Delta - 2 \)

83. Given that:

\[
\begin{array}{cccccc}
x & : & 40 & 50 & 60 & 70 & 80 \\
f(x) & : & 31 & 73 & 124 & 159 & 190 \\
\end{array}
\]

The value of \( \Delta^4 f(40) \) is:

(A) 45  
(B) 37  
(C) 26  
(D) 21

84. Given:

\[
\begin{array}{cccccc}
x & : & 0 & 1 & 2 & 3 & 4 & 5 \\
y & : & 4930 & 5026 & 5122 & 5217 & 5312 & 5407 \\
\end{array}
\]

Using Newton’s backward interpolation formula, the value of \( y^*(5) \) is:

(A) 5.4129  
(B) 1.0333  
(C) -2.1564  
(D) -3.4167
85. Given:

\[
\begin{array}{cccccc}
  x & : & 0 & 0.25 & 0.50 & 0.75 & 1.00 \\
  y & : & 0 & 0.06153 & 0.22222 & 0.39560 & 0.5 \\
\end{array}
\]

Using Simpson’s one-third rule, the value of \(\int_{0}^{1} y \, dx\) is:

(A) 0.23108  
(B) 0.36459  
(C) 0.45632  
(D) 0.53516

86. Using Regula-Falsi method, a root of equation \(x^3 - 5x - 7 = 0\) is:

(A) 1.059  
(B) 1.853  
(C) 2.748  
(D) None of these

87. Given \(\frac{dy}{dx} = x + y\) with \(y(0) = 0\). Then using Euler’s method, the value of \(y(0.6)\) by taking step size \(h = 0.2\), is:

(A) 1.686  
(B) 0.128  
(C) 2.321  
(D) None of these

88. Consider the following C program segment:

```c
printf("going, one, \n two, \n three, \n");
```

Then the output is:

(A) going, one,  
    two,  
    three,  

(B) going, one, two, three,  

(C) going three, two, one  

(D) None of the above
89. Consider the following statements in C:

```
int i = 2, j = 3, k = 4;
float x = 1.0, y = 1.5;
```

Then the value of the expression \( i + j - k \times x + y \), is:

(A) 3.5  
(B) 3  
(C) 2.5  
(D) 2

90. Which of the following is not a valid statement in C?

(A) \( y = \text{sqrt}(100); \)
(B) \( x = 7.5 \% 3; \)
(C) \( p = x/y; \)
(D) None of the above

91. Which of the following statements is true in C language?

(A) An if statement must always include an else clause.
(B) An if statement may include only simple statements.
(C) A switch statement can always be replaced by a series of if....else statements.
(D) A switch expression can be of any type.

92. The volume of the parallelepiped whose coterminous edges are represented by

\[
\vec{a} = 7\hat{i} - 5\hat{j} - 3\hat{k}, \quad \vec{b} = \hat{i} + 2\hat{j} - \hat{k}, \quad \vec{c} = -3\hat{i} + 7\hat{j} + 5\hat{k},
\]

is:

(A) 30 cubic units  
(B) 60 cubic units  
(C) 90 cubic units  
(D) None of these
93. A particle moves along the curve \( x = t^3 + 1, \ y = t^2, \ z = 2t + 5 \), where \( t \) is the
time. Then the component of velocity at \( t = 1 \) in the direction of \( \hat{i} + \hat{j} + 3\hat{k} \) is:

(A) \( \sqrt{11} \)  
(B) \( \sqrt{15} \)  
(C) \( \sqrt{19} \)  
(D) \( \sqrt{23} \)

94. The value of \( \lambda \) so that the vector \( \vec{F} = (x + 3y)\hat{i} + (y - 2z)\hat{j} + (x + \lambda z)\hat{k} \) is
solenoidal, is:

(A) 0  
(B) 3  
(C) 1  
(D) –2

95. The circulation of \( \vec{f} \) round the curve \( C \), where \( \vec{f} = y\hat{i} + z\hat{j} + x\hat{k} \) and \( C \) is the
circle \( x^2 + y^2 = 1, \ z = 0 \) is:

(A) \( 2\pi \)  
(B) \( -\pi \)  
(C) 0  
(D) None of these

96. Using Gauss divergence theorem, the value of the integral

\[
\iint_S \left[ (x^3 - yz)\hat{i} - 2x^2y\hat{j} + 2\hat{k} \right] \cdot \hat{n} \ dS
\]

where \( S \) is the surface of the cube bounded
by the planes \( x = 0, \ y = 0, \ z = 0, \ z = a, \) is :

(A) \( \frac{a^5}{2} \)  
(B) \( \frac{a^5}{5} \)  
(C) \( \frac{a^5}{3} \)  
(D) None of the above
97. The value of \( \frac{(\cos \theta + i \sin \theta)^6}{(\cos \theta - i \sin \theta)^4} \) is :

- (A) 1
- (B) \((\cos 10 \theta + i \sin 10 \theta)\)
- (C) \((\cos 2 \theta - i \sin 2 \theta)\)
- (D) None of the above

98. The expansion of \( \sin 5 \theta \) is :

- (A) \(5 \cos^4 \theta \sin \theta + 10 \cos^2 \theta \sin^3 \theta + \sin^5 \theta\)
- (B) \(5 \cos^4 \theta \sin \theta - 10 \cos^2 \theta \sin^3 \theta - \sin^5 \theta\)
- (C) \(5 \cos^4 \theta \sin \theta - 10 \cos^2 \theta \sin^3 \theta + \sin^5 \theta\)
- (D) None of the above

99. Sum of the series \(\frac{1}{1.3} + \frac{1}{5.7} + \frac{1}{9.11} + \cdots\) is :

- (A) \(\pi\)
- (B) \(\frac{\pi}{2}\)
- (C) \(\frac{\pi}{4}\)
- (D) \(\frac{\pi}{8}\)

100. Sum of the series \(\cos x + \cos 3x + \cos 5x + \cdots\) to \(n\) terms is :

- (A) \(\frac{1}{2} \sin 2nx \cosec x\)
- (B) \(\sin^2 nx \cos x\)
- (C) \(2 \sin nx \cos x\)
- (D) None of the above
GENERAL APTITUDE

101. fecund : infertile :: ______ : fleet
   (A) rapid  (B) slow
   (C) fertilizer  (D) damp

102. Find the wrong term in the sequence :
   121, 143, 186, 198, 264
   (A) 121  (B) 143  (C) 186  (D) 198

103. Directions: Study the following information carefully and answer the question given below:

It has been given that—
A is + from point B states B is to the NORTH of A.
A is = from point B states B is to the SOUTH of A.
A is || from point B states A is to the East of B.
A is * from point B states A is to the WEST of B.

Now, S is =20 m from point P. Point Q is =15 m from point R. Point U is + 15 m from Point V. Point T is || 20 m from point V. Point U is || 16 m from point Q. Point R is || 30 m from point P.

What is the shortest distance between the point T and the point which is to the East of Q ?
   (A) 25 m  (B) 26 m  (C) 27 m  (D) 28 m
104. Directions : Study the following information carefully and answer the question given below :

Eight persons – Sarin, Rahi, Akasa, Pavi, Preet, Gunjan, Taran and Namya belong to a family which consists of three generations and two married couples. Preet is the sister of only son of Akasa. Pavi is the daughter in law of Sarin. Rahi is the mother of Akasa. Sarin is the grandfather of Taran who is the daughter of Pavi. Namya is the maternal uncle of Gunjan.

Four of the following five are alike in some way and hence form a group. Which of the following is the one that does not belong to the group ?

(A) Sarin and Preet (B) Akasa and Taran
(C) Pavi and Namya (D) Rahi and Preet

105. Directions : Read the instructions and answer the following question :

Eight persons are sitting around a square table in such a way that four of them are sitting at corners while four of them are sitting at the middle of each edge of the table. All of them are facing towards the centre of the table. Each of them weight is different in kg such that no two persons have the same weight. Weight of the persons sitting at corners of the table is in a multiple of 3 kg and weight of the persons sitting at the edge of the table is in a multiple of 4 kg.

R is sitting second to the left of P, whose weight is 36 kg. Only one person is sitting between R and the one, whose weight is 72 kg. Third lightest person and third heaviest person are not sitting adjacent to each other. V is sitting to the immediate right of Q, who is not sitting at corner of the table. The one, whose weight is 60 kg, is sitting to the immediate right of the one, whose weight is 42 kg. The one, who is sitting third to the left of the one, whose weight is 42 kg, is 24 kg lighter than Q. W is sitting to the immediate left of S, whose weight is 81 kg. Two persons are sitting between W and the one, whose weight is 84 kg. Difference between the weights of R and one of the immediate neighbors of R is 3 kg. Weight of T is twice as the weight of U, who is sitting second to the right of T.

How many persons are sitting between the one, whose weight is 51 kg and second lightest person, when counted from right of second lightest person ?

(A) 3 (B) 2
(C) 1 (D) None of these
106. Directions: Read the information carefully and answer the question:

In a certain code language,
'speak nicely to all' is coded as "ka cu ma he"
'all are like us' is coded as " si fo he to"
'teach us lesson nicely' is coded as " po ma fo re"
'lesson like all humans' is coded as "he re gu si"

What would be the code for 'nicely'?
(A) he  (B) ma
(C) si (D) fo

107. Select a suitable figure from the Answer Figures that would replace the question mark (?)

Problem Figures: Answer Figures:

![Problem Figure](image1)

1 2 3 4

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

108. Find the number of triangles in the given figure:

![Triangle Figure](image2)

(A) 16  (B) 22
(C) 28  (D) 32
109. **Directions**: In each question below a statement followed by assumptions numbered I and II. Consider the statement and decide which of the given assumptions is implicit? Give answer:

A: if only assumption I is implicit.
B: if only assumption II is implicit.
C: if either assumption I or II is implicit.
D: if neither assumption I nor II is implicit.
E: if both the assumptions are implicit.

**Statement**:

A sentence in the letter to the candidates called for written exams—you have to bear your expenses on travel etc.

**Assumptions**:

I. If not clarified, all the candidates may claim reimbursement of expenses.
II. Many organizations reimburse expenses on travel to candidates called to written examination.

(A) B  (B) C  
(C) D  (D) E

110. The positions of first and fifth letters of the word ‘SEMANTIC’ are interchanged. Similarly, the position of second and sixth and so on till the fourth and eighth letters are interchanged. In the new arrangement thus formed, how many letters are there in between the letter which is third from the right and third from the left in the English alphabetical order?

(A) One  (B) Two  
(C) Three  (D) Four
111. Find the synonym of **Redolent**:

   (A) ubiquitous  (B) odorous  
   (C) shy  (D) bellicose

112. Find the antonym of **Placate**:

   (A) appease  (B) strip  
   (C) tremendous  (D) enrage

113. Read each part of the sentence to find out whether is there any grammatical error in it. The error if in any part of the sentence, the option given in that part will be the answer:

   (A) Though he has promoted to  (B) the bank's board as a director  
   (C) he continues to carry out  (D) all his current responsibilities.

114. In the question given below an/a idiom/phrase is given in bold which is then followed by four options which then try to decipher its meaning as used in the sentence. Choose the option which gives the correct meaning:

   Some people now wonder whether we just **pay lip-service** or genuinely subscribe to democracy.

   (A) pay oral tribute  (B) attach no value  
   (C) remain indifferent  (D) show only outward respect

115. One word substitution: **One who is well versed in any subject a critical judge of any art particularly fine arts**:

   (A) Connoisseur  (B) Litterateur  
   (C) Itinerate  (D) Altruist
116. Which one of the following words is correctly spelt?

(A) Circuiteous  
(B) Chivelery  
(C) Clairvoyant  
(D) Cavelcade

117. From the given options choose the correct words suitable to fill in the blank spaces:

Another area that needs.................attention is the financial system, which must be.................to lend more.

(A) hassles, removal  
(B) arrangement, profitability  
(C) lost, simplify  
(D) immediate, activated

118. In the following question, some part of the sentence may have errors. Find out which part of the sentence has an error and select the appropriate option:

In another year, a capital receipt (A) /was credited as the (B)/ profit and loss account (C)/ but shown as an extraordinary item(D).

(A) A  
(B) B  
(C) C  
(D) D

119. We will travel............rough terrain on our way to our house.

(A) over  
(B) for  
(C) about  
(D) in

120. Directions: Given below the sentence which has been divided into four parts. Choose the option which gives the correct sequence of the parts:

to accept digital transactions due to the network(A)/ connectivity issues and a reluctance (B)/many merchants, especially in rural areas, remain unable or unwilling(C)/ to pay charges for what are often low-value transactions(D)/.

(A) CABD  
(B) CBAD  
(C) ACDB  
(D) BACD