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S. Rahul 13/12/2022

SET–"X"

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(PHD/URS-EE-DEC.-2022)

Poonam 13-12-2022

Sr. No. 10057

Code A

MATHEMATICS

Time : 1¼ Hours **Total Questions : 100** **Max. Marks : 100**

Roll No. ______________ (in figure) ______________________ (in words)

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Set–X
Code–A

Question No.	Questions
1.	The infimum and the supremum of the set $\left\{\frac{(-1)^n}{n} : n \in N\right\}$ are respectively (1) $1, \frac{-1}{2}$ (2) $-1, \frac{1}{2}$ (3) $-1, 0$ (4) None of these
2.	Which of the following sequence is divergent ? (1) $a_n = 1 + \frac{2}{n}$ (2) $b_n = \frac{3n-1}{1+2n}$ (3) $c_n = 1 + \frac{(-1)^n}{n}$ (4) $d_n = \sin n$
3.	Consider the statements : (a) The series $\frac{1}{3} - \frac{2}{5} + \frac{3}{7} - \frac{4}{9} + \ldots\ldots\ldots\ldots$ is convergent. (b) The series $1 + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \ldots\ldots\ldots\ldots$ is convergent. Then (1) Both the statements (a) and (b) are true (2) The statement (a) is true and (b) is false (3) The statement (a) is false and (b) is true (4) Neither (a) nor (b) is true

Question No.	Questions
4.	Every bounded sequence has at least one limit point. This represents (1) Archimedean Property (2) Heine-Borel theorem (3) Bolzano-Weierstress theorem (4) Denseness Property
5.	Let $f : [0, \infty) \to R$ be a function, where R denotes the set of all real numbers. Then which one of the following statements is true ? (1) If f is continuous and $\lim_{x \to \infty} f(x)$ is finite, then f is uniformly continuous. (2) If f is bounded and continuous, then f is uniformly continuous. (3) If f is uniformly continuous, then $\lim_{x \to \infty} f(x)$ exists. (4) None of these
6.	Which of the following is false ? (1) The sequence $\{f_n\}$, where $f_n(x) = \frac{1}{x+n}$, is uniformly convergent in any interval [0, b], b > 0. (2) The sequence $\{f_n\}$, where $f_n(x) = \frac{n^2 x}{1+n^3 x^2}$, is uniformly convergent on the interval [0, 1]. (3) The sequence $\{f_n\}$, where $f_n(x) = \tan^{-1} nx, x \geq 0$, is uniformly convergent in any interval [a, b], a > 0. (4) None of these

Question No.	Questions
7.	For which of the following function, Rolle's theorem is not applicable ? (1) $f(x) = \cos 2x$ in $[-\pi/4, \pi/4]$ (2) $f(x) = \frac{\sin x}{e^x}$ in $[0, \pi]$ (3) $f(x) = x^3 - 6x^2 + 11x - 6$ in $[1, 3]$ (4) $f(x) = \|x\|$ in $[-1, 1]$
8.	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 $U(f, P)$ is (1) 23/36 (2) 31/36 (3) 49/36 (4) None of these
9.	If a function f defined on [0, 1] as $f(x) = \begin{cases} \sin\left(\frac{1}{x}\right), & \text{if } x \text{ is irrational} \\ 0, & \text{otherwise} \end{cases}$, then (1) f is not bounded (2) f is R-integrable (3) f is not R-integrable since f is not bounded (4) f is not R-integrable since lower and upper integrals of f are unequal

Question No.	Questions
10.	Consider the following improper integrals $I_1 = \int_0^\infty \frac{\sin^2 x}{x^2} dx$ and $I_2 = \int_1^\infty \frac{x^3}{(1+x)^5} dx$, then (1) Both are divergent (2) I_1 converges but not I_2 (3) I_2 converges but not I_1 (4) Both are convergent
11.	Which of the following functions is not a function of bounded variation ? (1) $f(x) = \begin{cases} x\sin(\pi/x), & \text{if } 0 < x \le 1 \\ 0 & , \text{if } x = 0 \end{cases}$ (2) $f(x) = \begin{cases} x^2\sin(1/x), & \text{if } x \ne 0 \\ 0 & , \text{if } x = 0 \end{cases}$ (3) $f(x) = 3x^2 - 2x^3, -2 \le x \le 2$ (4) None of these
12.	Choose the incorrect statement. (1) The set of all irrational numbers in [0, 1] is measurable. (2) Every non-empty one set has positive measure. (3) Every subset of a set of measure zero is not of measure zero. (4) None of these
13.	The directional derivative of the function $\phi(x, y) = \frac{xy}{x^2 + y^2}$ at the point (0, 1) along a line making an angle of 30° with positive direction of x-axis is (1) $\frac{2}{\sqrt{3}}$ (2) $\frac{\sqrt{3}}{2}$ (3) $\sqrt{3}$ (4) None of these

Question No.	Questions
14.	The metric space (R, d), where d is a usual metric, is (1) compact (2) disconnected (3) connected but not compact (4) compact and connected
15.	In a metric space (0, 1] with usual metric d (x, y) = $\lvert x - y \rvert$, the sequence $<\frac{1}{n}>$ is a (1) Not a Cauchy sequence (2) Cauchy sequence but does not converge in (0, 1] (3) Cauchy sequence that is convergent in (0, 1] (4) None of these
16.	Let V be a vector space over R^3. Which one of the following is not a subspace of V ? (1) $\{(x, y, z) : 3x + y - z = 0, x, y, z \in R\}$ (2) $\{(x, y, z) : x + y - z = 0, 2x + 3y - z = 0, x , y, z \in R\}$ (3) $\{(x, y, z) : x - 3y + 4z = 0, x, y, z \in R\}$ (4) $\{(x, y, z) : x + y \geq 0, x, y, z \in R\}$
17.	The value of k for which the vector u = (1, k, 5) in V_3 (R) can be expressed as a linear combination of vectors v = (1, – 3, 2) and w = (2, – 1, 1) is (1) 3 (2) –8 (3) –2 (4) None of these

Question No.	Questions
18.	The dimension of the subspace W of R^4 generated by $\{(3, 8, -3, -5), (1, -2, 5, -3), (2, 3, 1, -4)\}$ is (1) 1 (2) 3 (3) 2 (4) None of these
19.	The rank of the matrix $\begin{bmatrix} 1 & 2 & 1 \\ -3 & -6 & -3 \\ 5 & 10 & 5 \end{bmatrix}$ is (1) 1 (2) 2 (3) 3 (4) None of these
20.	The system of equations $2x - 3y + z = 9$; $x + y + z = 6$; $x - y + z = 2$ has (1) a unique solution (2) infinite solutions (3) no solution (4) none of these
21.	Consider the matrix $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$, then (1) A has no real eigen values. (2) A has both positive and negative real eigen values. (3) All real eigen values of A are positive. (4) All real eigen values of A are negative.

Question No.	Questions
22.	Which of the following is a linear transformation ? (1) $T(x, y) = (1 + x, y)$ for all $(x, y) \in R^2$ (2) $T(x, y) = (x, x + y)$ for all $(x, y) \in R^2$ (3) $T(x, y) = (x^2, y)$ for all $(x, y) \in R^2$ (4) None of these
23.	The matrix representing the linear transformation $T : R^2 \to R^2$ defined by $T(x_1, x_2) = (2x_2, 3x_1 - x_2)$ relative to the basis {(1, 3), (2, 5)} is (1) $\begin{bmatrix} 30 & 48 \\ 18 & 29 \end{bmatrix}$ (2) $\begin{bmatrix} -30 & 48 \\ 18 & -29 \end{bmatrix}$ (3) $\begin{bmatrix} 30 & 48 \\ -18 & -29 \end{bmatrix}$ (4) $\begin{bmatrix} -30 & -48 \\ 18 & 29 \end{bmatrix}$
24.	Let C^3 be a complex inner product space. If the vectors $u_1 = (1, 2i, i)$, $u_2 = (0, 1 + i, 1)$, $u_3 = (2, 1 - i, i) \in C^3$, then the vector orthogonal to both u_1 and u_3 is (1) $(-3 + i, -i, 1 - 5i)$ (2) $(-3 + i, -i, 1 + 5i)$ (3) $(3 + i, -i, 1 + 5i)$ (4) None of these
25.	The quadratic form corresponding to symmetric matrix $\begin{bmatrix} 9 & 3 & -3 \\ 3 & 2 & -4 \\ -3 & -4 & 2 \end{bmatrix}$ is (1) $9x^2 - 2y^2 + 2z^2 - 6xy - 6xz - 8yz$ (2) $9x^2 + 2y^2 + 2z^2 + 6xy - 6xz - 8yz$ (3) $9x^2 + 2y^2 - 2z^2 + 6xy + 6xz + 8yz$ (4) None of these

Question No.	Questions
26.	The radius of convergence of the power series $\sum_{n=0}^{\infty} \frac{(n!)^2}{(2n)!} z^n$ is (1) 4 (2) 3 (3) 2 (4) None of these
27.	Which one of the following functions f (z), of the complex variable z, is analytic over the entire complex plane ? (1) $f(z) = \ln(z)$ (2) $f(z) = e^{1/z}$ (3) $f(z) = \frac{1}{1-z}$ (4) $f(z) = \cos z$
28.	If $u = (x - 1)^3 - 3xy^2 + 3y^2$ is the real part of an analytic function $f(z) = u + iv$, then the imaginary part v of f (z) is (1) $3x^2y - 6xy - 3y + y^3 + c$ (2) $3x^2y + 6xy + 3y + y^3 + c$ (3) $3x^2y - 6xy + 3y - y^3 + c$ (4) None of these
29.	The value of the integral $\int_C \bar{z}\, dz$, from $z = 0$ to $z = 4 + 2i$ along the curve C given by $z = t^2 + it$, is equal to (1) $5 - \frac{8}{3}i$ (2) $10 - \frac{8}{3}i$ (3) $10 - \frac{4}{3}i$ (4) None of these

Question No.	Questions
30.	The value of the integral $\int_C \frac{e^{-z}}{z^2} dz$, where C is a unit circle about the origin, described in positive sense, is equal to (1) 0 (2) πi (3) $-2\pi i$ (4) None of these
31.	The Laurent series expansion of $f(z) = \frac{z}{(z-1)(z-3)}$ for $0 < \lvert z-1 \rvert < 2$, is equal to (1) $\frac{-3}{4}\sum_{n=0}^{\infty}\frac{(z-1)^n}{2^n} - \frac{1}{2(z-1)}$ (2) $\frac{3}{4}\sum_{n=0}^{\infty}\frac{(z-1)^n}{2^n} - \frac{1}{4(z-1)}$ (3) $\frac{1}{4}\sum_{n=0}^{\infty}\frac{(z-1)^{-n}}{2^n} + \frac{(z-1)}{2}$ (4) None of these
32.	The residue of the function $f(z) = \frac{1}{(z^2+1)^3}$ at $z = i$, is (1) $\frac{3}{16i}$ (2) $\frac{3}{2i}$ (3) $\frac{4}{3i}$ (4) None of these

Question No.	Questions
33.	The fixed points of the Mobius transformation $w = \frac{(2+i)z-2}{z+i}$ are (1) $i, -i$ (2) $0, 1$ (3) $-1, 1$ (4) $1+i, 1-i$
34.	The image of circle $\|z-2\| = 2$ under the Mobius transformation $w = \frac{z}{z+1}$ is a circle in w-plane with (1) Centre $\left(\frac{1}{5}, 0\right)$ and radius $\frac{2}{5}$ (2) Centre $\left(\frac{2}{5}, 0\right)$ and radius $\frac{1}{5}$ (3) Centre $\left(\frac{1}{5}, 0\right)$ and radius $\frac{1}{5}$ (4) Centre $\left(\frac{2}{5}, 0\right)$ and radius $\frac{2}{5}$
35.	If 9 colours are used to paint 100 houses, then atleast ______ houses will be of the same colour. (1) 18 (2) 15 (3) 12 (4) 10
36.	The congruence $35x \equiv 14 \pmod{21}$ has (1) 5 solutions (2) 6 solutions (3) 7 solutions (4) No solution

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Question No.	Questions
37.	The primitive roots of 3^2 are (1) 3, 7 (2) 2, 5 (3) 5, 7 (4) None of these
38.	Let G = {0, 1, 2, 3, 4, 5, 6, 7} be a group under the binary operation 'addition modulo 8', then the order of element 5, is (1) 1 (2) 2 (3) 4 (4) 8
39.	The centre of a non-abelian group of order 343 always has _______ elements in its centre. (1) 3 (2) 7 (3) 5 (4) None of these
40.	Let G be a group of order 20449. Then (1) G has only one Sylow-11 subgroup (2) G has only two Sylow-11 subgroups (3) G has only four Sylow-11 subgroups (4) None of these
41.	The non-isomorphic abelian groups of order 20 are (1) $Z_4, Z_2 \times Z_2 \times Z_5$ (2) $Z_8, Z_2 \times Z_5$ (3) $Z_4 \times Z_5, Z_2 \times Z_2 \times Z_5$ (4) None of these

Question No.	Questions
42.	Let Z [x] be the ring of polynomials over the ring of integers. Then (1) the ideal <x> is a prime ideal but not a maximal ideal. (2) the ideal <x> is not a prime ideal but a maximal ideal. (3) the ideal <x> is a prme ideal as well as a maximal ideal. (4) the ideal <x> is neither a prime ideal nor a maximal ideal.
43.	Which of the following is not a unique factorization domain ? (1) A Euclidean ring. (2) The ring < Z, +, . > of integers. (3) $Z[\sqrt{-5}]$ (4) None of these
44.	Which one of the following polynomial is irreducible over the field Q of rational numbers ? (1) $2x^5 + 15x^3 + 3x + 6$ (2) $x^3 + 3x + 1$ (3) $8x^3 - 6x - 1$ (4) All of the above
45.	The degree of splitting field of $x^4 - x^2 - 2$ over the field Q of rational numbers, is (1) 3 (2) 4 (3) 2 (4) None of these

Question No.	Questions
46.	Let F be a finite field and let K/F be a field extension of degree 6. Then the Galois group of K/F is isomorphic to (1) the cyclic group of order 6 (2) the permutation group on {1, 2, 3} (3) the permutation group on {1, 2, 3, 4, 5, 6} (4) the permutation group on {1}
47.	Which of the following spaces is not separable ? (1) R with the trivial topology (2) The Cantor set as a subspace of R (3) R with the discrete topology (4) None of these
48.	Which one of the following topological spaces is not compact ? (1) Indiscrete topological space (2) Infinite discrete topological space (3) A topological space with cofinite topology (4) None of these
49.	Let X be a topological space and U be a proper dense open subset of X. Then which of the following statement is true ? (1) If X is connected, then U is connected. (2) If X is compact, then U is compact. (3) If X\U is compact, then X is compact. (4) If X is compact, then X\U is compact.

Question No.	Questions
50.	Let X and Y be two topological spaces and let $f : X \rightarrow Y$ be a continuous function. Then (1) $f^{-1}(K)$ is connected if $K \subset Y$ is connected (2) $f^{-1}(K)$ is compact if $K \subset Y$ is compact (3) $f(K)$ is connected if $K \subset X$ is connected (4) None of these
51.	For the initial value problem (IVP) $y' = f(x, y)$, $y(0) = 0$, which of the following statement is true ? (1) $f(x, y) = \sqrt{xy}$ satisfies Lipschitz's condition and so IVP has unique solution. (2) $f(x, y) = \sqrt{xy}$ does not satisfy Lipschitz's condition and so IVP has no solution. (3) $f(x, y) = \|y\|$ satisfies Lipschitz's condition and so IVP has unique solution. (4) $f(x, y) = \|y\|$ does not satisfy Lipschitz's condition still the IVP has unique solution.
52.	The solution of the differential equation $\frac{dy}{dx} = 2xy$, $y(0) = 1$ by Picard's method upto third approximation is (1) $1 + x^2 + \frac{x^4}{2} + \frac{x^6}{6}$ (2) $1 + x^2 + \frac{3x^4}{2} + \frac{x^6}{6}$ (3) $1 + x^2 + \frac{x^4}{4} + \frac{x^6}{6}$ (4) None of these

Question No.	Questions
53.	Using method of variation of parameters, the solution of the differential equation $y'' - 2y' = e^x \sin x$, is (1) $y = c_1 + c_2 e^{2x} - \frac{1}{2} e^x \sin x$ (2) $y = c_1 e^x + c_2 e^{-x} - \frac{1}{2} e^x \sin x$ (3) $y = c_1 + c_2 e^x + \frac{1}{2} e^x \sin x$ (4) None of these
54.	Let n be non-negative integer. The eigen values of the Sturm-Liouville problem $y'' + \lambda y = 0$ with boundary conditions $y(0) = y(2\pi)$, $y'(0) = y'(2\pi)$ are (1) n (2) $n^2 \pi^2$ (3) $n \pi$ (4) n^2
55.	Green's function of the boundary value problem $\frac{d^2u}{dx^2} + u = 0,\ u(0) = 0,\ u\left(\frac{\pi}{2}\right) = 0$ is given by (1) $G(x, \xi) = \cos \xi \sin x,\ 0 \le x < \xi$ (2) $G(x, \xi) = \cosh \xi \sinh x,\ 0 \le x < \xi$ (3) $G(x, \xi) = x(1 - \xi),\ 0 \le x < \xi$ (4) None of these
56.	The solution of Partial differential equation $xz\,p + yz\,q = xy$ is (1) $\phi(xy, yz - y^2) = 0$ (2) $\phi(x/y, z + y^2) = 0$ (3) $\phi(x/y, xy - z^2) = 0$ (4) None of these

Question No.	Questions
57.	The integral surface for the Cauchy problem $\frac{\partial z}{\partial x}+\frac{\partial z}{\partial y}=1$ which passes through the circle $z=0,\ x^2+y^2=1$ is (1) $x^2+y^2+2z^2+2zx-2yz-1=0$ (2) $x^2+y^2+2z^2+2zx+2yz-1=0$ (3) $x^2+y^2+2z^2-2zx-2yz-1=0$ (4) None of these
58.	The partial differential equation $(x+1)\frac{\partial^2 u}{\partial x^2}-2(x+2)\frac{\partial^2 u}{\partial x\,\partial y}+(x+3)\frac{\partial^2 u}{\partial y^2}=0$ is (1) Elliptic (2) Hyperbolic (3) Parabolic (4) None of these
59.	Using method of separation of variables, the solution of Partial differential equation $\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}=0$ subject to the boundary conditions : $u(0, y)=\sin y$ for all y and $u(\infty, y)=0$ for all y is given by (1) $u(x, y)=e^{-x}\sin y$ (2) $u(x, y)=e^{x}\sin y$ (3) $u(x, y)=e^{-2x}\sin y$ (4) None of these

Question No.	Questions

60. Let $u(x, t) = e^{iwx}\, v(t)$ with $v(0) = 1$ be a solution to $\frac{\partial u}{\partial t} = \frac{\partial^3 u}{\partial x^3}$. Then

(1) $u(x, t) = e^{iw(x - w^2 t)}$
(2) $u(x, t) = e^{iwx - w^2 t}$
(3) $u(x, t) = e^{iw(x + w^2 t)}$
(4) $u(x, t) = e^{iw^3(x - t)}$

61. Using Newton Raphson's method, the smallest positive root of the equation $3x^3 - 9x^2 + 8 = 0$, lying between 1 and 2, is

(1) 1.0327
(2) 1.2261
(3) 1.6514
(4) None of these

62. Using Gauss Elimination method, the solution of following equations

$4x + 3y + 2z = 8, \quad x + y + 2z = 7, \quad 3x + 2y + 4z = 13$

is given by

(1) $x = -1, y = 2, z = 3$
(2) $x = 1, y = 2, z = 3$
(3) $x = -1, y = -2, z = 3$
(4) $x = 1, y = -2, z = 3$

63. Given that

x	3	7	9	10
f (x)	168	120	72	63

The value of third divided difference of the function f (x) is

(1) 5
(2) 1
(3) –1
(4) –2

Question No.	Questions
64.	Consider the data given below : | x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | f (x) | 0 | 4.13 | 7.20 | 9.25 | 10.25 | 10.00 | 9.05 | 7.12 | 6.2 | Using Simpson's one third rule, the value of $\int_0^8 f(x)\,dx$ is (1) 34.5 (2) 47.3 (3) 52.8 (4) 60.4
65.	Given $\frac{dy}{dx} = -y$ with $y(0) = 1$. Then using Euler's method, the value of $y(0.02)$ by taking step size $h = 0.01$, is (1) 3.6845 (2) 2.7862 (3) 0.9801 (4) 0.5401
66.	The Euler's equation corresponding to the functional $\int_0^{\pi} (y'^2 - y^2 + 4y\cos x)\,dx$ subject to $y(0) = 0$, $y(\pi) = 0$ is (1) $\frac{d^2y}{dx^2} + y = 2\sin x$ (2) $\frac{d^2y}{dx^2} + y = 2\cos x$ (3) $\frac{d^2y}{dx^2} - y = 2\tan x$ (4) None of these

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Question No.	Questions
67.	The extremal of the functional $I[y(x)] = \int_1^2 (y'^2 - 2xy)\,dx$ subject to $y(1) = 0, y(2) = -1$ is (1) $y = \frac{1}{6}(x - x^3)$ (2) $y = x^2 - 1$ (3) $y = \frac{1}{6}(7x - x^3)$ (4) None of these
68.	The extremal of $\int_1^2 \frac{\dot{x}^2}{t^3} dt$; $x(1) = 3, x(2) = 18$ $\left(\text{where } \dot{x} \equiv \frac{dx}{dt}\right)$ using Lagrange's equation is given by which of the following ? (1) $x = \frac{15}{7}t^3 + \frac{6}{7}$ (2) $x = 5t^2 - 2$ (3) $x = 5t^3 + 3$ (4) $x = t^4 + 2$
69.	The solution of the linear integral equation $\phi(x) = (1+x)^2 + \int_{-1}^{1} (x\xi + x^2\xi^2)\,\phi(\xi)\,d\xi$, is (1) $\phi(x) = 1 + 6x + \frac{25}{9}x^2$ (2) $\phi(x) = 1 - 6x + \frac{5}{9}x^2$ (3) $\phi(x) = 1 + 3x - \frac{25}{9}x^2$ (4) None of these

Question No.	Questions
70.	The solution to the integral equation $\phi(x) = x + \int_0^x \sin(x-\xi)\phi(\xi)\,d\xi$ is given by (1) $x^2 + \frac{x^3}{3}$ (2) $x - \frac{x^3}{3!}$ (3) $x^2 - \frac{x^3}{3!}$ (4) $x + \frac{x^3}{3!}$
71.	The resolvent kernel for the integral equation $\phi(x) = 29 + 6x + \int_0^x [5 - 6(x-\xi)]\phi(\xi)\,d\xi$, is (1) $9e^{3(x-\xi)} - 4e^{2(x-\xi)}$ (2) $9e^{2(x-\xi)} - 4e^{3(x-\xi)}$ (3) $9e^{3(x-\xi)} - e^{-2(x-\xi)}$ (4) None of these
72.	Consider the two dimensional motion of a mass m attached to one end of a spring whose other end is fixed. Let k be the spring constant. The kinetic energy T and the potential energy V of the system are given by $T = \frac{1}{2}m(\dot{r}^2 + (r\dot{\theta})^2)$ and $V = \frac{1}{2}kr^2$, where $\dot{r} = \frac{dr}{dt}$ and $\dot{\theta} = \frac{d\theta}{dt}$ with t as time. Then which of the following statement is correct ? (1) r is an ignorable coordinate (2) θ is not an ignorable coordinate (3) $r^2\dot{\theta}$ remains constant throughout the motion (4) $r\dot{\theta}$ remains constant throughout the motion

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Question No.	Questions
73.	The Lagrange's equation for a simple pendulum is, (where symbols have their usual meanings) (1) $\dot{\theta}+\frac{g}{\ell}\sin\theta=0$ (2) $\ddot{\theta}+\frac{g}{\ell}\sin\theta=0$ (3) $\ddot{\theta}+\frac{g}{\ell}\tan\theta=0$ (4) None of these
74.	Let q_i and $\dot{q}_i$ respectively are the generalized coordinates and velocity of a mechanical system and p_i are its generalized momenta. If H is the Hamiltonian of the system, then Hamilton's equations of motion are (1) $\dot{q}_i=\frac{\partial H}{\partial p_i}, \dot{p}_i=\frac{\partial H}{\partial q_i}$ (2) $\dot{q}_i=-\frac{\partial H}{\partial p_i}, \dot{p}_i=\frac{\partial H}{\partial q_i}$ (3) $\dot{q}_i=\frac{\partial H}{\partial p_i}, \dot{p}_i=-\frac{\partial H}{\partial q_i}$ (4) $\dot{q}_i=-\frac{\partial H}{\partial p_i}, \dot{p}_i=-\frac{\partial H}{\partial q_i}$
75.	If $L=[L_1, L_2, L_3]$ is the vector moment of the external forces about a fixed point O, $\omega=[\omega_1, \omega_2, \omega_3]$ the angular velocity, and A, B, C are the principal moments of inertia, then Euler's dynamical equations of motion are (1) $L_1=A\omega_1-(B-C)\omega_2\omega_3, L_2=B\omega_2-(C-A)\omega_3\omega_1, L_3=C\omega_3-(A-B)\omega_1\omega_2$ (2) $L_1=A\dot{\omega}_1-(B-C)\omega_2\omega_3, L_2=B\dot{\omega}_2-(C-A)\omega_3\omega_1, L_3=C\dot{\omega}_3-(A-B)\omega_1\omega_2$ (3) $L_1=A\dot{\omega}_1+(B-C)\omega_2\omega_3, L_2=B\dot{\omega}_2+(C-A)\omega_3\omega_1, L_3=C\dot{\omega}_3+(A-B)\omega_1\omega_2$ (4) None of these

Question No.	Questions
76.	An integer is chosen at random from two hundred digits. Then the probability that the integer is divisible is divisible by 6 or 8 is (1) 3/4 (2) 1/2 (3) 3/8 (4) 1/4
77.	In a bolts factory, machines I, II and III manufacture respectively 25%, 35% and 40% of the total bolts. Of their total output 5%, 4% and 2% are respectively defective bolts. A bolt is drawn at random from the product. If the bolt drawn is found to be defective, what is the probability that it is manufactured by machine II ? (1) 0.41 (2) 0.27 (3) 0.13 (4) None of these
78.	Let X be a continuous random variable with probability density function (p.d.f.) defined as $f(x) = 6x(1-x), 0 \le x \le 1$. Then the value of number b such that $P(X < b) = P(X > b)$ is (1) 1/4 (2) 3/4 (3) 1/2 (4) None of these
79.	If X and Y are two random variables having joint density function given by $f(x, y) = \begin{cases} 6x^2y \ ; & 0 < x < 1, 0 < y < 1 \\ 0 \ ; & \text{otherwise} \end{cases}$ Then $P(X + Y < 1)$ is (1) 1/4 (2) 1/10 (3) 3/8 (4) None of these

Question No.	Questions
80.	For k = 1, 2, ..., 10, let the probability density function of the random variable X_k is given by $$f_{x_k}(x) = \begin{cases} \frac{e^{-\frac{x}{k}}}{k}, & x > 0 \\ 0, & \text{otherwise} \end{cases}$$ Then the value of $E\left(\sum_{k=1}^{10} k X_k\right)$ is equal to (1) 385 (2) 256 (3) 144 (4) 110
81.	If 2% of the items manufactured by a factory are defective, then the probability that there are 3 defective items in a sample of 100 items is (1) 0.48 (2) 0.33 (3) 0.27 (4) 0.18
82.	For a certain normal distribution, the first moment about 10 is 40 and the fourth moment about 50 is 48. Then the mean and standard deviation of the distribution respectively are (1) 20, 3 (2) 30, 4 (3) 50, 2 (4) None of these
83.	The characteristic function of χ^2–distribution with n degrees of freedom is (1) $(1 - 2it)^{n/2}$ (2) $(1 + 2it)^{n/2}$ (3) $(1 - 2it)^{-n/2}$ (4) None of these

Question No.	Questions
84.	If Tchebycheff's inequality for a random variable X with mean 12 is $P\{6 < X < 18\} \geq \frac{3}{4}$, then the standard deviation of X is (1) 2 (2) 3 (3) 8 (4) None of these
85.	The sum of all the elements of any row of the transition probability matrix of a Markov chain is (1) 0 (2) 1 (3) 2 (4) None of these
86.	Consider a discrete time Markov chain on the state space {1, 2, 3} with one-step transition probability matrix $\begin{bmatrix} 0 & 0.2 & 0.8 \\ 0.5 & 0 & 0.5 \\ 0.6 & 0.4 & 0 \end{bmatrix}$. Then the period of the Markov chain is (1) 3 (2) 2 (3) 1 (4) 0
87.	Let $\{X_t\}$ and $\{Y_t\}$ be two independent pure birth processes with birth rates λ_1 and λ_2 respectively. Let $Z_t = X_t + Y_t$. Then (1) $\{Z_t\}$ is not a pure birth process. (2) $\{Z_t\}$ is a pure birth process with birth rate $\lambda_1 + \lambda_2$. (3) $\{Z_t\}$ is a pure birth process with birth rate min (λ_1, λ_2). (4) $\{Z_t\}$ is a pure birth process with birth rate $\lambda_1 \lambda_2$.

Question No.	Questions
88.	Let X and Y be independent and identically distributed (i.i.d.) random variables uniformly distributed on (0, 4). Then P (X > Y | X < 2 Y) is (1) 2/3 (2) 5/6 (3) 1/4 (4) 1/3
89.	If X and Y are independent normal variates with zero expectations and variances σ_1^2 and σ_2^2, then $Z = \frac{XY}{\sqrt{X^2+Y^2}}$ is normal with variance (1) $\sigma_z^2 = \frac{1}{\left(\frac{1}{\sigma_1^2}+\frac{1}{\sigma_2^2}\right)}$ (2) $\sigma_z^2 = \sigma_1^2 + \sigma_2^2$ (3) $\sigma_z^2 = \frac{1}{\sigma_1^2}+\frac{1}{\sigma_2^2}$ (4) None of these
90.	In testing H : $\mu = 100$ against A : $\mu \neq 100$ at the 10% level of significance, H is rejected if (1) 100 is contained in the 90% confidence interval (2) The value of the test statistic is in the acceptance region (3) The p-value is less than 0.10 (4) The p-value is greater than 0.10

Question No.	Questions
91.	Let p be the probability that a coin will fall head in a single toss in order to test $H_0 = p = \frac{1}{2}$ against $H_1 : p = \frac{3}{4}$. The coin is tossed 5 times and H_0 is rejected if more than 3 heads are obtained. Then the probability of type I error is (1) 1/16 (2) 3/16 (3) 5/16 (4) None of these
92.	Given the observations 0.8, 0.71, 0.9, 1.2, 1.68, 1.4, 0.88, 1.62 from the uniform distribution on $(\theta - 0.2, \theta + 0.8)$ with $-\infty < \theta < \infty$, which of the following is a maximum likelihood estimate for θ ? (1) 0.7 (2) 0.9 (3) 1.1 (4) 1.3
93.	If $X_1, X_2, X_3, \ldots\ldots, X_n$ is a random sample from a normal population $N(\mu, 1)$. Then $t = \frac{1}{n}\sum_{i=1}^{n} X_i^2$ is a unbiased estimator of (1) μ^2 (2) $\mu^2 - 1$ (3) $1 - \mu^2$ (4) $\mu^2 + 1$
94.	Let $X_1, X_2, \ldots\ldots, X_n$ be a random sample of size n from a p-variate Normal distribution with mean μ and positive definite covariance matrix $\sum$. Choose the correct statement (1) $(X_1 - \mu)' \sum^{-1} (X_1 - \mu)$ has chi-square distribution with 1 d.f. (2) $\overline{X}\,\overline{X}'$ has Wishart distribution with p d.f. (3) $\sum_{i=1}^{n} (X_i - \mu)(X_i - \mu)'$ has Wishart distribution with n d.f. (4) $X_1 + X_2$ and $X_1 - X_2$ are independently distributed.

Question No.	Questions
95.	In a trivariate distribution : $\sigma_1 = 2, \sigma_2 = \sigma_3 = 3, r_{12} = 0.7, r_{23} = r_{31} = 0.5$. Then $R_{1.23}$ is (1) 0.1423 (2) 0.7211 (3) 0.4892 (4) None of these
96.	The total number of all possible Latin squares of order 3 is (1) 12 (2) 9 (3) 6 (4) None of these
97.	The Mean time to failure (MTTF) for an exponential distribution with parameter λ is (1) λ (2) λ^2 (3) $1/\lambda$ (4) None of these
98.	The maximum value of $Z = 2x + 3y$ subject to the constraints : $x + y \le 30$; $3 \le y \le 12$; $x - y \ge 0$; $0 \le x \le 20$, is (1) 72 (2) 60 (3) 49 (4) None of these

Question No.	Questions
99.	Men arrive in a queue according to a Poisson process with rate λ_1 and women arrive in the same queue according to another Poisson process with rate λ_2. The arrivals of men and women are independent. The probability that the first arrival in the queue is a man is (1) $\frac{\lambda_1}{\lambda_1+\lambda_2}$ (2) $\frac{\lambda_2}{\lambda_1+\lambda_2}$ (3) $\frac{\lambda_1}{\lambda_2}$ (4) $\frac{\lambda_2}{\lambda_1}$
100.	Arrivals at a telephone booth are considered to be Poisson with an average time of 12 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 4 minutes. Then the probability that a person arriving at the booth will have to wait in the queue is (1) $\frac{2}{3}$ (2) $\frac{1}{3}$ (3) $\frac{1}{6}$ (4) None of these

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MATHEMATICS

Sr. No.________

Time : 1¼ Hours **Total Questions : 100** **Max. Marks : 100**

Roll No. ____________ (in figure)________________________ (in words)

Name : ________________________ Father's Name : ________________

Mother's Name : ____________________ Date of Examination : ________________

(Signature of the candidate) (Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/ INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

1. **All questions are compulsory.**
2. The candidates must return the Question book-let as well as OMR answer-sheet to the Invigilator concerned before leaving the Examination Hall, failing which a case of use of unfair-means / mis-behaviour will be registered against him / her, in addition to lodging of an FIR with the police. Further the answer-sheet of such a candidate will not be evaluated.
3. Keeping in view the transparency of the examination system, carbonless OMR Sheet is provided to the candidate so that a copy of OMR Sheet may be kept by the candidate.
4. Question Booklet along with answer key of all the A,B,C and D code will be uploaded on the university website after the conduct of Entrance Examination. In case there is any discrepancy in the Question Booklet/Answer Key, the same may be brought to the notice of the Controller of Examinations in writing within 24 hours of uploading the same on the University Website. Thereafter, no complaint in any case, will be considered.
5. The candidate MUST NOT do any rough work or writing in the OMR Answer-Sheet. Rough work, if any, may be done in the question book-let itself. Answers **MUST NOT** be ticked in the Question book-let.
6. **There will be no negative marking. Each correct answer will be awarded one full mark. Cutting, erasing, overwriting and more than one answer in OMR Answer-Sheet will be treated as incorrect answer.**
7. Use only Black or Blue BALL POINT PEN of good quality in the OMR Answer-Sheet.
8. BEFORE ANSWERING THE QUESTIONS, THE CANDIDATES SHOULD ENSURE THAT THEY HAVE BEEN SUPPLIED CORRECT AND COMPLETE BOOK-LET. COMPLAINTS, IF ANY, REGARDING MISPRINTING ETC. WILL NOT BE ENTERTAINED 30 MINUTES AFTER STARTING OF THE EXAMINATION.

Question No.	Questions
1.	The resolvent kernel for the integral equation $\phi(x) = 29 + 6x + \int_0^x [5 - 6(x-\xi)]\,\phi(\xi)\,d\xi$, is (1) $9\,e^{3(x-\xi)} - 4\,e^{2(x-\xi)}$ (2) $9\,e^{2(x-\xi)} - 4\,e^{3(x-\xi)}$ (3) $9\,e^{3(x-\xi)} - e^{-2(x-\xi)}$ (4) None of these
2.	Consider the two dimensional motion of a mass m attached to one end of a spring whose other end is fixed. Let k be the spring constant. The kinetic energy T and the potential energy V of the system are given by $T = \frac{1}{2} m (\dot{r}^2 + (r\dot{\theta})^2)$ and $V = \frac{1}{2} k r^2$, where $\dot{r} = \frac{dr}{dt}$ and $\dot{\theta} = \frac{d\theta}{dt}$ with t as time. Then which of the following statement is correct ? (1) r is an ignorable coordinate (2) θ is not an ignorable coordinate (3) $r^2 \dot{\theta}$ remains constant throughout the motion (4) $r\,\dot{\theta}$ remains constant throughout the motion
3.	The Lagrange's equation for a simple pendulum is, (where symbols have their usual meanings) (1) $\dot{\theta} + \frac{g}{\ell} \sin\theta = 0$ (2) $\ddot{\theta} + \frac{g}{\ell} \sin\theta = 0$ (3) $\ddot{\theta} + \frac{g}{\ell} \tan\theta = 0$ (4) None of these

Question No.	Questions
4.	Let q_i and $\dot{q}_i$ respectively are the generalized coordinates and velocity of a mechanical system and p_i are its generalized momenta. If H is the Hamiltonian of the system, then Hamilton's equations of motion are (1) $\dot{q}_i = \frac{\partial H}{\partial p_i}, \dot{p}_i = \frac{\partial H}{\partial q_i}$ (2) $\dot{q}_i = -\frac{\partial H}{\partial p_i}, \dot{p}_i = \frac{\partial H}{\partial q_i}$ (3) $\dot{q}_i = \frac{\partial H}{\partial p_i}, \dot{p}_i = -\frac{\partial H}{\partial q_i}$ (4) $\dot{q}_i = -\frac{\partial H}{\partial p_i}, \dot{p}_i = -\frac{\partial H}{\partial q_i}$
5.	If $L = [L_1, L_2, L_3]$ is the vector moment of the external forces about a fixed point O, $\omega = [\omega_1, \omega_2, \omega_3]$ the angular velocity, and A, B, C are the principal moments of inertia, then Euler's dynamical equations of motion are (1) $L_1 = A\omega_1 - (B-C)\,\omega_2\omega_3, L_2 = B\omega_2 - (C-A)\,\omega_3\omega_1, L_3 = C\omega_3 - (A-B)\,\omega_1\,\omega_2$ (2) $L_1 = A\dot{\omega}_1 - (B-C)\,\omega_2\omega_3, L_2 = B\dot{\omega}_2 - (C-A)\,\omega_3\omega_1, L_3 = C\dot{\omega}_3 - (A-B)\,\omega_1\,\omega_2$ (3) $L_1 = A\dot{\omega}_1 + (B-C)\,\omega_2\omega_3, L_2 = B\dot{\omega}_2 + (C-A)\,\omega_3\omega_1, L_3 = C\dot{\omega}_3 + (A-B)\,\omega_1\,\omega_2$ (4) None of these
6.	An integer is chosen at random from two hundred digits. Then the probability that the integer is divisible is divisible by 6 or 8 is (1) 3/4 (2) 1/2 (3) 3/8 (4) 1/4
7.	In a bolts factory, machines I, II and III manufacture respectively 25%, 35% and 40% of the total bolts. Of their total output 5%, 4% and 2% are respectively defective bolts. A bolt is drawn at random from the product. If the bolt drawn is found to be defective, what is the probability that it is manufactured by machine II ? (1) 0.41 (2) 0.27 (3) 0.13 (4) None of these

Question No.	Questions
8.	Let X be a continuous random variable with probability density function (p.d.f.) defined as $f(x) = 6x(1-x), 0 \le x \le 1$. Then the value of number b such that $P(X < b) = P(X > b)$ is (1) 1/4 (2) 3/4 (3) 1/2 (4) None of these
9.	If X and Y are two random variables having joint density function given by $f(x, y) = \begin{cases} 6x^2y \ ; \ 0 < x < 1, 0 < y < 1 \\ 0 \quad ; \text{otherwise} \end{cases}$ Then $P(X + Y < 1)$ is (1) 1/4 (2) 1/10 (3) 3/8 (4) None of these
10.	For k = 1, 2, ..., 10, let the probability density function of the random variable X_k is given by $f_{X_k}(x) = \begin{cases} \dfrac{e^{-\frac{x}{k}}}{k}, \ x > 0 \\ 0 \ , \text{otherwise} \end{cases}$ Then the value of $E\left(\sum_{k=1}^{10} k X_k\right)$ is equal to (1) 385 (2) 256 (3) 144 (4) 110

Question No.	Questions
11.	For the initial value problem (IVP) $y' = f(x, y)$, $y(0) = 0$, which of the following statement is true ? (1) $f(x, y) = \sqrt{xy}$ satisfies Lipschitz's condition and so IVP has unique solution. (2) $f(x, y) = \sqrt{xy}$ does not satisfy Lipschitz's condition and so IVP has no solution. (3) $f(x, y) = \|y\|$ satisfies Lipschitz's condition and so IVP has unique solution. (4) $f(x, y) = \|y\|$ does not satisfy Lipschitz's condition still the IVP has unique solution.
12.	The solution of the differential equation $\frac{dy}{dx} = 2xy$, $y(0) = 1$ by Picard's method upto third approximation is (1) $1 + x^2 + \frac{x^4}{2} + \frac{x^6}{6}$ (2) $1 + x^2 + \frac{3x^4}{2} + \frac{x^6}{6}$ (3) $1 + x^2 + \frac{x^4}{4} + \frac{x^6}{6}$ (4) None of these
13.	Using method of variation of parameters, the solution of the differential equation $y'' - 2y' = e^x \sin x$, is (1) $y = c_1 + c_2 e^{2x} - \frac{1}{2} e^x \sin x$ (2) $y = c_1 e^x + c_2 e^{-x} - \frac{1}{2} e^x \sin x$ (3) $y = c_1 + c_2 e^x + \frac{1}{2} e^x \sin x$ (4) None of these

Question No.	Questions
14.	Let n be non-negative integer. The eigen values of the Sturm-Liouville problem $y'' + \lambda y = 0$ with boundary conditions $y(0) = y(2\pi)$, $y'(0) = y'(2\pi)$ are (1) n (2) $n^2 \pi^2$ (3) $n \pi$ (4) n^2
15.	Green's function of the boundary value problem $\frac{d^2u}{dx^2} + u = 0,\ u(0) = 0,\ u\left(\frac{\pi}{2}\right) = 0$ is given by (1) $G(x, \xi) = \cos \xi \sin x,\ 0 \le x < \xi$ (2) $G(x, \xi) = \cosh \xi \sinh x,\ 0 \le x < \xi$ (3) $G(x, \xi) = x(1 - \xi),\ 0 \le x < \xi$ (4) None of these
16.	The solution of Partial differential equation $xz\,p + yz\,q = x\,y$ is (1) $\phi(xy, yz - y^2) = 0$ (2) $\phi(x/y, z + y^2) = 0$ (3) $\phi(x/y, xy - z^2) = 0$ (4) None of these
17.	The integral surface for the Cauchy problem $\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y} = 1$ which passes through the circle $z = 0$, $x^2 + y^2 = 1$ is (1) $x^2 + y^2 + 2z^2 + 2zx - 2yz - 1 = 0$ (2) $x^2 + y^2 + 2z^2 + 2zx + 2yz - 1 = 0$ (3) $x^2 + y^2 + 2z^2 - 2zx - 2yz - 1 = 0$ (4) None of these

Question No.	Questions
18.	The partial differential equation $(x+1)\frac{\partial^2 u}{\partial x^2} - 2(x+2)\frac{\partial^2 u}{\partial x \partial y} + (x+3)\frac{\partial^2 u}{\partial y^2} = 0$ is (1) Elliptic (2) Hyperbolic (3) Parabolic (4) None of these
19.	Using method of separation of variables, the solution of Partial differential equation $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ subject to the boundary conditions : $u(0, y) = \sin y$ for all y and $u(\infty, y) = 0$ for all y is given by (1) $u(x, y) = e^{-x} \sin y$ (2) $u(x, y) = e^{x} \sin y$ (3) $u(x, y) = e^{-2x} \sin y$ (4) None of these
20.	Let $u(x, t) = e^{iwx}\, v(t)$ with $v(0) = 1$ be a solution to $\frac{\partial u}{\partial t} = \frac{\partial^3 u}{\partial x^3}$. Then (1) $u(x, t) = e^{iw(x - w^2 t)}$ (2) $u(x, t) = e^{iwx - w^2 t}$ (3) $u(x, t) = e^{iw(x + w^2 t)}$ (4) $u(x, t) = e^{iw^3 (x - t)}$

Question No.	Questions
21.	The Laurent series expansion of $f(z) = \frac{z}{(z-1)(z-3)}$ for $0 < \|z-1\| < 2$, is equal to
	(1) $\frac{-3}{4}\sum_{n=0}^{\infty}\frac{(z-1)^n}{2^n} - \frac{1}{2(z-1)}$ (2) $\frac{3}{4}\sum_{n=0}^{\infty}\frac{(z-1)^n}{2^n} - \frac{1}{4(z-1)}$
	(3) $\frac{1}{4}\sum_{n=0}^{\infty}\frac{(z-1)^{-n}}{2^n} + \frac{(z-1)}{2}$ (4) None of these
22.	The residue of the function $f(z) = \frac{1}{(z^2+1)^3}$ at $z = i$, is
	(1) $\frac{3}{16i}$ (2) $\frac{3}{2i}$
	(3) $\frac{4}{3i}$ (4) None of these
23.	The fixed points of the Mobius transformation $w = \frac{(2+i)z-2}{z+i}$ are
	(1) $i, -i$ (2) $0, 1$ (3) $-1, 1$ (4) $1+i, 1-i$
24.	The image of circle $\|z-2\| = 2$ under the Mobius transformation $w = \frac{z}{z+1}$ is a circle in w-plane with
	(1) Centre $\left(\frac{1}{5}, 0\right)$ and radius $\frac{2}{5}$ (2) Centre $\left(\frac{2}{5}, 0\right)$ and radius $\frac{1}{5}$
	(3) Centre $\left(\frac{1}{5}, 0\right)$ and radius $\frac{1}{5}$ (4) Centre $\left(\frac{2}{5}, 0\right)$ and radius $\frac{2}{5}$

Question No.	Questions
25.	If 9 colours are used to paint 100 houses, then atleast ______ houses will be of the same colour. (1) 18 (2) 15 (3) 12 (4) 10
26.	The congruence $35x \equiv 14 \pmod{21}$ has (1) 5 solutions (2) 6 solutions (3) 7 solutions (4) No solution
27.	The primitive roots of 3^2 are (1) 3, 7 (2) 2, 5 (3) 5, 7 (4) None of these
28.	Let G = {0, 1, 2, 3, 4, 5, 6, 7} be a group under the binary operation 'addition modulo 8', then the order of element 5, is (1) 1 (2) 2 (3) 4 (4) 8
29.	The centre of a non-abelian group of order 343 always has ______ elements in its centre. (1) 3 (2) 7 (3) 5 (4) None of these

Question No.	Questions
30.	Let G be a group of order 20449. Then (1) G has only one Sylow-11 subgroup (2) G has only two Sylow-11 subgroups (3) G has only four Sylow-11 subgroups (4) None of these
31.	Which of the following functions is not a function of bounded variation ? (1) $f(x) = \begin{cases} x \sin(\pi/x), & \text{if } 0 < x \le 1 \\ 0, & \text{if } x = 0 \end{cases}$ (2) $f(x) = \begin{cases} x^2 \sin(1/x), & \text{if } x \ne 0 \\ 0, & \text{if } x = 0 \end{cases}$ (3) $f(x) = 3x^2 - 2x^3, -2 \le x \le 2$ (4) None of these
32.	Choose the incorrect statement. (1) The set of all irrational numbers in [0, 1] is measurable. (2) Every non-empty one set has positive measure. (3) Every subset of a set of measure zero is not of measure zero. (4) None of these
33.	The directional derivative of the function $\phi(x, y) = \frac{xy}{x^2 + y^2}$ at the point (0, 1) along a line making an angle of 30° with positive direction of x-axis is (1) $\frac{2}{\sqrt{3}}$ (2) $\frac{\sqrt{3}}{2}$ (3) $\sqrt{3}$ (4) None of these

Question No.	Questions
34.	The metric space (R, d), where d is a usual metric, is (1) compact (2) disconnected (3) connected but not compact (4) compact and connected
35.	In a metric space (0, 1] with usual metric d (x, y) = $\lvert x - y \rvert$, the sequence $< \frac{1}{n} >$ is a (1) Not a Cauchy sequence (2) Cauchy sequence but does not converge in (0, 1] (3) Cauchy sequence that is convergent in (0, 1] (4) None of these
36.	Let V be a vector space over R^3. Which one of the following is not a subspace of V ? (1) $\{(x, y, z) : 3x + y - z = 0, x, y, z \in R\}$ (2) $\{(x, y, z) : x + y - z = 0, 2x + 3y - z = 0, x, y, z \in R\}$ (3) $\{(x, y, z) : x - 3y + 4z = 0, x, y, z \in R\}$ (4) $\{(x, y, z) : x + y \geq 0, x, y, z \in R\}$
37.	The value of k for which the vector u = (1, k, 5) in V_3 (R) can be expressed as a linear combination of vectors v = (1, – 3, 2) and w = (2, – 1, 1) is (1) 3 (2) – 8 (3) – 2 (4) None of these

Question No.	Questions
38.	The dimension of the subspace W of R^4 generated by $\{(3, 8, -3, -5), (1, -2, 5, -3), (2, 3, 1, -4)\}$ is (1) 1 (2) 3 (3) 2 (4) None of these
39.	The rank of the matrix $\begin{bmatrix} 1 & 2 & 1 \\ -3 & -6 & -3 \\ 5 & 10 & 5 \end{bmatrix}$ is (1) 1 (2) 2 (3) 3 (4) None of these
40.	The system of equations $2x - 3y + z = 9$; $x + y + z = 6$; $x - y + z = 2$ has (1) a unique solution (2) infinite solutions (3) no solution (4) none of these
41.	Let p be the probability that a coin will fall head in a single toss in order to test $H_0 = p = \frac{1}{2}$ against $H_1 : p = \frac{3}{4}$. The coin is tossed 5 times and H_0 is rejected if more than 3 heads are obtained. Then the probability of type I error is (1) 1/16 (2) 3/16 (3) 5/16 (4) None of these
42.	Given the observations 0.8, 0.71, 0.9, 1.2, 1.68, 1.4, 0.88, 1.62 from the uniform distribution on $(\theta - 0.2, \theta + 0.8)$ with $-\infty < \theta < \infty$, which of the following is a maximum likelihood estimate for θ ? (1) 0.7 (2) 0.9 (3) 1.1 (4) 1.3

Question No.	Questions
43.	If $X_1, X_2, X_3, \ldots\ldots, X_n$ is a random sample from a normal population $N(\mu, 1)$. Then $t = \frac{1}{n}\sum_{i=1}^{n} X_i^2$ is a unbiased estimator of (1) μ^2 (2) $\mu^2 - 1$ (3) $1 - \mu^2$ (4) $\mu^2 + 1$
44.	Let $X_1, X_2, \ldots.., X_n$ be a random sample of size n from a p-variate Normal distribution with mean μ and positive definite covariance matrix $\sum$. Choose the correct statement (1) $(X_1 - \mu)' \sum^{-1} (X_1 - \mu)$ has chi-square distribution with 1 d.f. (2) $\overline{X}\,\overline{X}'$ has Wishart distribution with p d.f. (3) $\sum_{i=1}^{n} (X_i - \mu)(X_i - \mu)'$ has Wishart distribution with n d.f. (4) $X_1 + X_2$ and $X_1 - X_2$ are independently distributed.
45.	In a trivariate distribution : $\sigma_1 = 2, \sigma_2 = \sigma_3 = 3, r_{12} = 0.7, r_{23} = r_{31} = 0.5$. Then $R_{1.23}$ is (1) 0.1423 (2) 0.7211 (3) 0.4892 (4) None of these
46.	The total number of all possible Latin squares of order 3 is (1) 12 (2) 9 (3) 6 (4) None of these

Question No.	Questions
47.	The Mean time to failure (MTTF) for an exponential distribution with parameter λ is (1) λ (2) λ^2 (3) $1/\lambda$ (4) None of these
48.	The maximum value of $Z = 2x + 3y$ subject to the constraints : $x + y \le 30$; $3 \le y \le 12$; $x - y \ge 0$; $0 \le x \le 20$, is (1) 72 (2) 60 (3) 49 (4) None of these
49.	Men arrive in a queue according to a Poisson process with rate λ_1 and women arrive in the same queue according to another Poisson process with rate λ_2. The arrivals of men and women are independent. The probability that the first arrival in the queue is a man is (1) $\frac{\lambda_1}{\lambda_1+\lambda_2}$ (2) $\frac{\lambda_2}{\lambda_1+\lambda_2}$ (3) $\frac{\lambda_1}{\lambda_2}$ (4) $\frac{\lambda_2}{\lambda_1}$
50.	Arrivals at a telephone booth are considered to be Poisson with an average time of 12 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 4 minutes. Then the probability that a person arriving at the booth will have to wait in the queue is (1) $\frac{2}{3}$ (2) $\frac{1}{3}$ (3) $\frac{1}{6}$ (4) None of these

Question No.	Questions
51.	Using Newton Raphson's method, the smallest positive root of the equation $3x^3 - 9x^2 + 8 = 0$, lying between 1 and 2, is (1) 1.0327 (2) 1.2261 (3) 1.6514 (4) None of these
52.	Using Gauss Elimination method, the solution of following equations $4x + 3y + 2z = 8$, $x + y + 2z = 7$, $3x + 2y + 4z = 13$ is given by (1) $x = -1, y = 2, z = 3$ (2) $x = 1, y = 2, z = 3$ (3) $x = -1, y = -2, z = 3$ (4) $x = 1, y = -2, z = 3$
53.	Given that x: 3, 7, 9, 10 f(x): 168, 120, 72, 63 The value of third divided difference of the function f(x) is (1) 5 (2) 1 (3) −1 (4) −2
54.	Consider the data given below : x: 0, 1, 2, 3, 4, 5, 6, 7, 8 f(x): 0, 4.13, 7.20, 9.25, 10.25, 10.00, 9.05, 7.12, 6.2 Using Simpson's one third rule, the value of $\int_0^8 f(x)\,dx$ is (1) 34.5 (2) 47.3 (3) 52.8 (4) 60.4

Question No.	Questions
55.	Given $\frac{dy}{dx} = -y$ with $y(0) = 1$. Then using Euler's method, the value of $y(0.02)$ by taking step size $h = 0.01$, is (1) 3.6845 (2) 2.7862 (3) 0.9801 (4) 0.5401
56.	The Euler's equation corresponding to the functional $\int_0^{\pi} (y'^2 - y^2 + 4y \cos x)\, dx$ subject to $y(0) = 0$, $y(\pi) = 0$ is (1) $\frac{d^2y}{dx^2} + y = 2 \sin x$ (2) $\frac{d^2y}{dx^2} + y = 2 \cos x$ (3) $\frac{d^2y}{dx^2} - y = 2 \tan x$ (4) None of these
57.	The extremal of the functional $I[y(x)] = \int_1^2 (y'^2 - 2xy)\, dx$ subject to $y(1) = 0$, $y(2) = -1$ is (1) $y = \frac{1}{6}(x - x^3)$ (2) $y = x^2 - 1$ (3) $y = \frac{1}{6}(7x - x^3)$ (4) None of these

Question No.	Questions
58.	The extremal of $\int_1^2 \frac{\dot{x}^2}{t^3} dt$; x (1) = 3, x (2) = 18 $\left(\text{where } \dot{x} \equiv \frac{dx}{dt}\right)$ using Lagrange's equation is given by which of the following ? (1) $x = \frac{15}{7}t^3 + \frac{6}{7}$ (2) $x = 5t^2 - 2$ (3) $x = 5t^3 + 3$ (4) $x = t^4 + 2$
59.	The solution of the linear integral equation $\phi(x) = (1+x)^2 + \int_{-1}^{1} (x\xi + x^2\xi^2)\phi(\xi)\, d\xi$, is (1) $\phi(x) = 1 + 6x + \frac{25}{9}x^2$ (2) $\phi(x) = 1 - 6x + \frac{5}{9}x^2$ (3) $\phi(x) = 1 + 3x - \frac{25}{9}x^2$ (4) None of these
60.	The solution to the integral equation $\phi(x) = x + \int_0^x \sin(x-\xi)\phi(\xi)\, d\xi$ is given by (1) $x^2 + \frac{x^3}{3}$ (2) $x - \frac{x^3}{3!}$ (3) $x^2 - \frac{x^3}{3!}$ (4) $x + \frac{x^3}{3!}$

Question No.	Questions
61.	If 2% of the items manufactured by a factory are defective, then the probability that there are 3 defective items in a sample of 100 items is (1) 0.48 (2) 0.33 (3) 0.27 (4) 0.18
62.	For a certain normal distribution, the first moment about 10 is 40 and the fourth moment about 50 is 48. Then the mean and standard deviation of the distribution respectively are (1) 20, 3 (2) 30, 4 (3) 50, 2 (4) None of these
63.	The characteristic function of χ^2–distribution with n degrees of freedom is (1) $(1-2it)^{n/2}$ (2) $(1+2it)^{n/2}$ (3) $(1-2it)^{-n/2}$ (4) None of these
64.	If Tchebycheff's inequality for a random variable X with mean 12 is $P\{6 < X < 18\} \geq \frac{3}{4}$, then the standard deviation of X is (1) 2 (2) 3 (3) 8 (4) None of these
65.	The sum of all the elements of any row of the transition probability matrix of a Markov chain is (1) 0 (2) 1 (3) 2 (4) None of these

Question No.	Questions
66.	Consider a discrete time Markov chain on the state space {1, 2, 3} with one-step transition probability matrix $\begin{bmatrix} 0 & 0.2 & 0.8 \\ 0.5 & 0 & 0.5 \\ 0.6 & 0.4 & 0 \end{bmatrix}$. Then the period of the Markov chain is (1) 3 (2) 2 (3) 1 (4) 0
67.	Let $\{X_t\}$ and $\{Y_t\}$ be two independent pure birth processes with birth rates λ_1 and λ_2 respectively. Let $Z_t = X_t + Y_t$. Then (1) $\{Z_t\}$ is not a pure birth process. (2) $\{Z_t\}$ is a pure birth process with birth rate $\lambda_1 + \lambda_2$. (3) $\{Z_t\}$ is a pure birth process with birth rate min (λ_1, λ_2). (4) $\{Z_t\}$ is a pure birth process with birth rate $\lambda_1 \lambda_2$.
68.	Let X and Y be independent and identically distributed (i.i.d.) random variables uniformly distributed on (0, 4). Then $P(X > Y \mid X < 2Y)$ is (1) 2/3 (2) 5/6 (3) 1/4 (4) 1/3

Question No.	Questions
69.	**If X and Y are independent normal variates with zero expectations and variances σ_1^2 and σ_2^2, then $Z = \frac{XY}{\sqrt{X^2+Y^2}}$ is normal with variance** (1) $\sigma_z^2 = \frac{1}{\left(\frac{1}{\sigma_1^2}+\frac{1}{\sigma_2^2}\right)}$ (2) $\sigma_z^2 = \sigma_1^2 + \sigma_2^2$ (3) $\sigma_z^2 = \frac{1}{\sigma_1^2}+\frac{1}{\sigma_2^2}$ (4) None of these
70.	In testing $H : \mu = 100$ against $A : \mu \neq 100$ at the 10% level of significance, H is rejected if (1) 100 is contained in the 90% confidence interval (2) The value of the test statistic is in the acceptance region (3) The p-value is less than 0.10 (4) The p-value is greater than 0.10
71.	The non-isomorphic abelian groups of order 20 are (1) $Z_4, Z_2 \times Z_2 \times Z_5$ (2) $Z_8, Z_2 \times Z_5$ (3) $Z_4 \times Z_5, Z_2 \times Z_2 \times Z_5$ (4) None of these

Question No.	Questions
72.	Let Z [x] be the ring of polynomials over the ring of integers. Then (1) the ideal <x> is a prime ideal but not a maximal ideal. (2) the ideal <x> is not a prime ideal but a maximal ideal. (3) the ideal <x> is a prme ideal as well as a maximal ideal. (4) the ideal <x> is neither a prime ideal nor a maximal ideal.
73.	Which of the following is not a unique factorization domain ? (1) A Euclidean ring. (2) The ring < Z, +, . > of integers. (3) $Z[\sqrt{-5}]$ (4) None of these
74.	Which one of the following polynomial is irreducible over the field Q of rational numbers ? (1) $2x^5 + 15x^3 + 3x + 6$ (2) $x^3 + 3x + 1$ (3) $8x^3 - 6x - 1$ (4) All of the above
75.	The degree of splitting field of $x^4 - x^2 - 2$ over the field Q of rational numbers, is (1) 3 (2) 4 (3) 2 (4) None of these

Question No.	Questions
76.	Let F be a finite field and let K/F be a field extension of degree 6. Then the Galois group of K/F is isomorphic to (1) the cyclic group of order 6 (2) the permutation group on {1, 2, 3} (3) the permutation group on {1, 2, 3, 4, 5, 6} (4) the permutation group on {1}
77.	Which of the following spaces is not separable ? (1) R with the trivial topology (2) The Cantor set as a subspace of R (3) R with the discrete topology (4) None of these
78.	Which one of the following topological spaces is not compact ? (1) Indiscrete topological space (2) Infinite discrete topological space (3) A topological space with cofinite topology (4) None of these
79.	Let X be a topological space and U be a proper dense open subset of X. Then which of the following statement is true ? (1) If X is connected, then U is connected. (2) If X is compact, then U is compact. (3) If X\U is compact, then X is compact. (4) If X is compact, then X\U is compact.

Question No.	Questions
80.	Let X and Y be two topological spaces and let $f : X \to Y$ be a continuous function. Then (1) $f^{-1}(K)$ is connected if $K \subset Y$ is connected (2) $f^{-1}(K)$ is compact if $K \subset Y$ is compact (3) $f(K)$ is connected if $K \subset X$ is connected (4) None of these
81.	Consider the matrix $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$, then (1) A has no real eigen values. (2) A has both positive and negative real eigen values. (3) All real eigen values of A are positive. (4) All real eigen values of A are negative.
82.	Which of the following is a linear transformation ? (1) $T(x, y) = (1 + x, y)$ for all $(x, y) \in R^2$ (2) $T(x, y) = (x, x + y)$ for all $(x, y) \in R^2$ (3) $T(x, y) = (x^2, y)$ for all $(x, y) \in R^2$ (4) None of these

Question No.	Questions
83.	The matrix representing the linear transformation $T : R^2 \to R^2$ defined by $T(x_1, x_2) = (2x_2, 3x_1 - x_2)$ relative to the basis {(1, 3), (2, 5)} is (1) $\begin{bmatrix} 30 & 48 \\ 18 & 29 \end{bmatrix}$ (2) $\begin{bmatrix} -30 & 48 \\ 18 & -29 \end{bmatrix}$ (3) $\begin{bmatrix} 30 & 48 \\ -18 & -29 \end{bmatrix}$ (4) $\begin{bmatrix} -30 & -48 \\ 18 & 29 \end{bmatrix}$
84.	Let C^3 be a complex inner product space. If the vectors $u_1 = (1, 2i, i)$, $u_2 = (0, 1 + i, 1)$, $u_3 = (2, 1 - i, i) \in C^3$, then the vector orthogonal to both u_1 and u_3 is (1) $(-3 + i, -i, 1 - 5i)$ (2) $(-3 + i, -i, 1 + 5i)$ (3) $(3 - i, -i, 1 + 5i)$ (4) None of these
85.	The quadratic form corresponding to symmetric matrix $\begin{bmatrix} 9 & 3 & -3 \\ 3 & 2 & -4 \\ -3 & -4 & 2 \end{bmatrix}$ is (1) $9x^2 - 2y^2 + 2z^2 - 6xy - 6xz - 8yz$ (2) $9x^2 + 2y^2 + 2z^2 + 6xy - 6xz - 8yz$ (3) $9x^2 + 2y^2 - 2z^2 + 6xy + 6xz + 8yz$ (4) None of these

Question No.	Questions
86.	The radius of convergence of the power series $\sum_{n=0}^{\infty} \frac{(n!)^2}{(2n)!} z^n$ is (1) 4 (2) 3 (3) 2 (4) None of these
87.	Which one of the following functions f (z), of the complex variable z, is analytic over the entire complex plane ? (1) $f(z) = \ln(z)$ (2) $f(z) = e^{1/z}$ (3) $f(z) = \frac{1}{1-z}$ (4) $f(z) = \cos z$
88.	If $u = (x-1)^3 - 3xy^2 + 3y^2$ is the real part of an analytic function $f(z) = u + iv$, then the imaginary part v of f (z) is (1) $3x^2y - 6xy - 3y + y^3 + c$ (2) $3x^2y + 6xy + 3y + y^3 + c$ (3) $3x^2y - 6xy + 3y - y^3 + c$ (4) None of these
89.	The value of the integral $\int_C \bar{z}\, dz$, from $z = 0$ to $z = 4 + 2i$ along the curve C given by $z = t^2 + it$, is equal to (1) $5 - \frac{8}{3}i$ (2) $10 - \frac{8}{3}i$ (3) $10 - \frac{4}{3}i$ (4) None of these

Question No.	Questions
90.	The value of the integral $\int_C \frac{e^{-z}}{z^2} dz$, where C is a unit circle about the origin, described in positive sense, is equal to (1) 0 (2) πi (3) $-2\pi i$ (4) None of these
91.	The infimum and the supremum of the set $\left\{\frac{(-1)^n}{n} : n \in N\right\}$ are respectively (1) $1, \frac{-1}{2}$ (2) $-1, \frac{1}{2}$ (3) $-1, 0$ (4) None of these
92.	Which of the following sequence is divergent ? (1) $a_n = 1 + \frac{2}{n}$ (2) $b_n = \frac{3n-1}{1+2n}$ (3) $c_n = 1 + \frac{(-1)^n}{n}$ (4) $d_n = \sin n$

Question No.	Questions
93.	Consider the statements : (a) The series $\frac{1}{3}-\frac{2}{5}+\frac{3}{7}-\frac{4}{9}+$ .... is convergent. (b) The series $1+\frac{1}{2!}+\frac{1}{3!}+\frac{1}{4!}+$ .... is convergent. Then (1) Both the statements (a) and (b) are true (2) The statement (a) is true and (b) is false (3) The statement (a) is false and (b) is true (4) Neither (a) nor (b) is true
94.	Every bounded sequence has at least one limit point. This represents (1) Archimedean Property (2) Heine-Borel theorem (3) Bolzano-Weierstress theorem (4) Denseness Property
95.	Let f : [0, ∞) → R be a function, where R denotes the set of all real numbers. Then which one of the following statements is true ? (1) If f is continuous and $\lim_{x\to\infty} f(x)$ is finite, then f is uniformly continuous. (2) If f is bounded and continuous, then f is uniformly continuous. (3) If f is uniformly continuous, then $\lim_{x\to\infty} f(x)$ exists. (4) None of these

Question No.	Questions
96.	Which of the following is false ? (1) The sequence $\{f_n\}$, where $f_n(x) = \frac{1}{x+n}$, is uniformly convergent in any interval $[0, b]$, $b > 0$. (2) The sequence $\{f_n\}$, where $f_n(x) = \frac{n^2 x}{1+n^3 x^2}$, is uniformly convergent on the interval $[0, 1]$. (3) The sequence $\{f_n\}$, where $f_n(x) = \tan^{-1} nx$, $x \geq 0$, is uniformly convergent in any interval $[a, b]$, $a > 0$. (4) None of these
97.	For which of the following function, Rolle's theorem is not applicable ? (1) $f(x) = \cos 2x$ in $[-\pi/4, \pi/4]$ (2) $f(x) = \frac{\sin x}{e^x}$ in $[0, \pi]$ (3) $f(x) = x^3 - 6x^2 + 11x - 6$ in $[1, 3]$ (4) $f(x) = \lvert x \rvert$ in $[-1, 1]$
98.	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 $U(f, P)$ is (1) 23/36 (2) 31/36 (3) 49/36 (4) None of these

Question No.	Questions
99.	If a function f defined on [0, 1] as $f(x) = \begin{cases} \sin\left(\frac{1}{x}\right), & \text{if x is irrational} \\ 0, & \text{otherwise} \end{cases}$, then (1) f is not bounded (2) f is R-integrable (3) f is not R-integrable since f is not bounded (4) f is not R-integrable since lower and upper integrals of f are unequal
100.	Consider the following improper integrals $I_1 = \int_0^\infty \frac{\sin^2 x}{x^2} dx$ and $I_2 = \int_1^\infty \frac{x^3}{(1+x)^5} dx$, then (1) Both are divergent (2) I_1 converges but not I_2 (3) I_2 converges but not I_1 (4) Both are convergent

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MATHEMATICS

Sr. No.________

Time : 1¼ Hours **Total Questions : 100** **Max. Marks : 100**

Roll No. ______________ (in figure)______________________ (in words)

Name : ______________________ Father's Name : ______________

Mother's Name : __________________ Date of Examination : ____________

(Signature of the candidate) (Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/ INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

1. **All questions are compulsory.**
2. The candidates must return the Question book-let as well as OMR answer-sheet to the Invigilator concerned before leaving the Examination Hall, failing which a case of use of unfair-means / mis-behaviour will be registered against him / her, in addition to lodging of an FIR with the police. Further the answer-sheet of such a candidate will not be evaluated.
3. Keeping in view the transparency of the examination system, carbonless OMR Sheet is provided to the candidate so that a copy of OMR Sheet may be kept by the candidate.
4. Question Booklet along with answer key of all the A,B,C and D code will be uploaded on the university website after the conduct of Entrance Examination. In case there is any discrepancy in the Question Booklet/Answer Key, the same may be brought to the notice of the Controller of Examinations in writing within 24 hours of uploading the same on the University Website. Thereafter, no complaint in any case, will be considered.
5. The candidate MUST NOT do any rough work or writing in the OMR Answer-Sheet. Rough work, if any, may be done in the question book-let itself. Answers **MUST NOT** be ticked in the Question book-let.
6. **There will be no negative marking. Each correct answer will be awarded one full mark. Cutting, erasing, overwriting and more than one answer in OMR Answer-Sheet will be treated as incorrect answer.**
7. Use only Black or Blue <u>BALL POINT PEN</u> of good quality in the OMR Answer-Sheet.
8. BEFORE ANSWERING THE QUESTIONS, THE CANDIDATES SHOULD ENSURE THAT THEY HAVE BEEN SUPPLIED CORRECT AND COMPLETE BOOK-LET. COMPLAINTS, IF ANY, REGARDING MISPRINTING ETC. WILL NOT BE ENTERTAINED 30 MINUTES AFTER STARTING OF THE EXAMINATION.

Question No.	Questions
1.	The non-isomorphic abelian groups of order 20 are (1) $Z_4, Z_2 \times Z_2 \times Z_5$ (2) $Z_8, Z_2 \times Z_5$ (3) $Z_4 \times Z_5, Z_2 \times Z_2 \times Z_5$ (4) None of these
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7.	Which of the following spaces is not separable ? (1) R with the trivial topology (2) The Cantor set as a subspace of R (3) R with the discrete topology (4) None of these
8.	Which one of the following topological spaces is not compact ? (1) Indiscrete topological space (2) Infinite discrete topological space (3) A topological space with cofinite topology (4) None of these
9.	Let X be a topological space and U be a proper dense open subset of X. Then which of the following statement is true ? (1) If X is connected, then U is connected. (2) If X is compact, then U is compact. (3) If X\U is compact, then X is compact. (4) If X is compact, then X\U is compact.

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11.	Consider the matrix $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$, then (1) A has no real eigen values. (2) A has both positive and negative real eigen values. (3) All real eigen values of A are positive. (4) All real eigen values of A are negative.
12.	Which of the following is a linear transformation ? (1) $T(x, y) = (1 + x, y)$ for all $(x, y) \in R^2$ (2) $T(x, y) = (x, x + y)$ for all $(x, y) \in R^2$ (3) $T(x, y) = (x^2, y)$ for all $(x, y) \in R^2$ (4) None of these

Question No.	Questions
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Question No.	Questions
17.	Which one of the following functions f (z), of the complex variable z, is analytic over the entire complex plane ? (1) $f(z) = \ln(z)$ (2) $f(z) = e^{1/z}$ (3) $f(z) = \frac{1}{1-z}$ (4) $f(z) = \cos z$
18.	If $u = (x-1)^3 - 3xy^2 + 3y^2$ is the real part of an analytic function $f(z) = u + iv$, then the imaginary part v of f (z) is (1) $3x^2y - 6xy - 3y + y^3 + c$ (2) $3x^2y + 6xy + 3y + y^3 + c$ (3) $3x^2y - 6xy + 3y - y^3 + c$ (4) None of these
19.	The value of the integral $\int_C \bar{z}\, dz$, from $z = 0$ to $z = 4 + 2i$ along the curve C given by $z = t^2 + it$, is equal to (1) $5 - \frac{8}{3}i$ (2) $10 - \frac{8}{3}i$ (3) $10 - \frac{4}{3}i$ (4) None of these
20.	The value of the integral $\int_C \frac{e^{-z}}{z^2} dz$, where C is a unit circle about the origin, described in positive sense, is equal to (1) 0 (2) πi (3) $-2\pi i$ (4) None of these

Question No.	Questions
21.	The infimum and the supremum of the set $\left\{\frac{(-1)^n}{n} : n \in N\right\}$ are respectively (1) $1, \frac{-1}{2}$ (2) $-1, \frac{1}{2}$ (3) $-1, 0$ (4) None of these
22.	Which of the following sequence is divergent ? (1) $a_n = 1 + \frac{2}{n}$ (2) $b_n = \frac{3n-1}{1+2n}$ (3) $c_n = 1 + \frac{(-1)^n}{n}$ (4) $d_n = \sin n$
23.	Consider the statements : (a) The series $\frac{1}{3} - \frac{2}{5} + \frac{3}{7} - \frac{4}{9} + \ldots\ldots\ldots$ is convergent. (b) The series $1 + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \ldots\ldots\ldots$ is convergent. Then (1) Both the statements (a) and (b) are true (2) The statement (a) is true and (b) is false (3) The statement (a) is false and (b) is true (4) Neither (a) nor (b) is true
24.	Every bounded sequence has at least one limit point. This represents (1) Archimedean Property (2) Heine-Borel theorem (3) Bolzano-Weierstress theorem (4) Denseness Property

Question No.	Questions
25.	Let $f : [0, \infty) \to R$ be a function, where R denotes the set of all real numbers. Then which one of the following statements is true ? (1) If f is continuous and $\lim_{x \to \infty} f(x)$ is finite, then f is uniformly continuous. (2) If f is bounded and continuous, then f is uniformly continuous. (3) If f is uniformly continuous, then $\lim_{x \to \infty} f(x)$ exists. (4) None of these
26.	Which of the following is false ? (1) The sequence $\{f_n\}$, where $f_n(x) = \frac{1}{x+n}$, is uniformly convergent in any interval $[0, b], b > 0$. (2) The sequence $\{f_n\}$, where $f_n(x) = \frac{n^2 x}{1+n^3 x^2}$, is uniformly convergent on the interval [0, 1]. (3) The sequence $\{f_n\}$, where $f_n(x) = \tan^{-1} nx, x \geq 0$, is uniformly convergent in any interval $[a, b], a > 0$. (4) None of these
27.	For which of the following function, Rolle's theorem is not applicable ? (1) $f(x) = \cos 2x$ in $[-\pi/4, \pi/4]$ (2) $f(x) = \frac{\sin x}{e^x}$ in $[0, \pi]$ (3) $f(x) = x^3 - 6x^2 + 11x - 6$ in $[1, 3]$ (4) $f(x) = \lvert x \rvert$ in $[-1, 1]$

Question No.	Questions
28.	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 U (f, P) is (1) 23/36 (2) 31/36 (3) 49/36 (4) None of these
29.	If a function f defined on [0, 1] as $f(x) = \begin{cases} \sin\left(\frac{1}{x}\right), & \text{if x is irrational} \\ 0, & \text{otherwise} \end{cases}$, then (1) f is not bounded (2) f is R-integrable (3) f is not R-integrable since f is not bounded (4) f is not R-integrable since lower and upper integrals of f are unequal
30.	Consider the following improper integrals $I_1 = \int_0^\infty \frac{\sin^2 x}{x^2} dx$ and $I_2 = \int_1^\infty \frac{x^3}{(1+x)^5} dx$, then (1) Both are divergent (2) I_1 converges but not I_2 (3) I_2 converges but not I_1 (4) Both are convergent
31.	Let p be the probability that a coin will fall head in a single toss in order to test $H_0 = p = \frac{1}{2}$ against $H_1 : p = \frac{3}{4}$. The coin is tossed 5 times and H_0 is rejected if more than 3 heads are obtained. Then the probability of type I error is (1) 1/16 (2) 3/16 (3) 5/16 (4) None of these

Question No.	Questions
32.	Given the observations 0.8, 0.71, 0.9, 1.2, 1.68, 1.4, 0.88, 1.62 from the uniform distribution on $(\theta - 0.2, \theta + 0.8)$ with $-\infty < \theta < \infty$, which of the following is a maximum likelihood estimate for θ ? (1) 0.7 (2) 0.9 (3) 1.1 (4) 1.3
33.	If $X_1, X_2, X_3, \ldots\ldots, X_n$ is a random sample from a normal population $N(\mu, 1)$. Then $t = \frac{1}{n}\sum_{i=1}^{n} X_i^2$ is a unbiased estimator of (1) μ^2 (2) $\mu^2 - 1$ (3) $1 - \mu^2$ (4) $\mu^2 + 1$
34.	Let $X_1, X_2, \ldots\ldots, X_n$ be a random sample of size n from a p-variate Normal distribution with mean μ and positive definite covariance matrix $\sum$. Choose the correct statement (1) $(X_1 - \mu)' \sum^{-1} (X_1 - \mu)$ has chi-square distribution with 1 d.f. (2) $\overline{X}\,\overline{X}'$ has Wishart distribution with p d.f. (3) $\sum_{i=1}^{n} (X_i - \mu)(X_i - \mu)'$ has Wishart distribution with n d.f. (4) $X_1 + X_2$ and $X_1 - X_2$ are independently distributed.
35.	In a trivariate distribution : $\sigma_1 = 2$, $\sigma_2 = \sigma_3 = 3$, $r_{12} = 0.7$, $r_{23} = r_{31} = 0.5$. Then $R_{1.23}$ is (1) 0.1423 (2) 0.7211 (3) 0.4892 (4) None of these

Question No.	Questions
36.	The total number of all possible Latin squares of order 3 is (1) 12 (2) 9 (3) 6 (4) None of these
37.	The Mean time to failure (MTTF) for an exponential distribution with parameter λ is (1) λ (2) λ^2 (3) $1/\lambda$ (4) None of these
38.	The maximum value of $Z = 2x + 3y$ subject to the constraints : $x + y \le 30$; $3 \le y \le 12$; $x - y \ge 0$; $0 \le x \le 20$, is (1) 72 (2) 60 (3) 49 (4) None of these
39.	Men arrive in a queue according to a Poisson process with rate λ_1 and women arrive in the same queue according to another Poisson process with rate λ_2. The arrivals of men and women are independent. The probability that the first arrival in the queue is a man is (1) $\frac{\lambda_1}{\lambda_1 + \lambda_2}$ (2) $\frac{\lambda_2}{\lambda_1 + \lambda_2}$ (3) $\frac{\lambda_1}{\lambda_2}$ (4) $\frac{\lambda_2}{\lambda_1}$

Question No.	Questions
40.	Arrivals at a telephone booth are considered to be Poisson with an average time of 12 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 4 minutes. Then the probability that a person arriving at the booth will have to wait in the queue is (1) $\frac{2}{3}$ (2) $\frac{1}{3}$ (3) $\frac{1}{6}$ (4) None of these
41.	Using Newton Raphson's method, the smallest positive root of the equation $3x^3 - 9x^2 + 8 = 0$, lying between 1 and 2, is (1) 1.0327 (2) 1.2261 (3) 1.6514 (4) None of these
42.	Using Gauss Elimination method, the solution of following equations $4x + 3y + 2z = 8$, $x + y + 2z = 7$, $3x + 2y + 4z = 13$ is given by (1) $x = -1, y = 2, z = 3$ (2) $x = 1, y = 2, z = 3$ (3) $x = -1, y = -2, z = 3$ (4) $x = 1, y = -2, z = 3$
43.	Given that <table><tr><td>x</td><td>3</td><td>7</td><td>9</td><td>10</td></tr><tr><td>f(x)</td><td>168</td><td>120</td><td>72</td><td>63</td></tr></table>The value of third divided difference of the function f (x) is (1) 5 (2) 1 (3) –1 (4) –2

Question No.	Questions
44.	Consider the data given below :

x	0	1	2	3	4	5	6	7	8
f (x)	0	4.13	7.20	9.25	10.25	10.00	9.05	7.12	6.2

Using Simpson's one third rule, the value of $\int_0^8 f(x)\,dx$ is

(1) 34.5 (2) 47.3

(3) 52.8 (4) 60.4

45. Given $\frac{dy}{dx} = -y$ with y (0) = 1. Then using Euler's method, the value of y (0.02) by taking step size h = 0.01, is

(1) 3.6845 (2) 2.7862

(3) 0.9801 (4) 0.5401

46. The Euler's equation corresponding to the functional

$\int_0^{\pi} (y'^2 - y^2 + 4y\cos x)\,dx$ subject to y (0) = 0, y (π) = 0 is

(1) $\frac{d^2y}{dx^2} + y = 2\sin x$ (2) $\frac{d^2y}{dx^2} + y = 2\cos x$

(3) $\frac{d^2y}{dx^2} - y = 2\tan x$ (4) None of these

Question No.	Questions
47.	The extremal of the functional $I[y(x)] = \int_1^2 (y'^2 - 2xy)\,dx$ subject to $y(1) = 0,\ y(2) = -1$ is (1) $y = \frac{1}{6}(x - x^3)$ (2) $y = x^2 - 1$ (3) $y = \frac{1}{6}(7x - x^3)$ (4) None of these
48.	The extremal of $\int_1^2 \frac{\dot{x}^2}{t^3}\,dt$; $x(1) = 3,\ x(2) = 18$ $\left(\text{where } \dot{x} \equiv \frac{dx}{dt}\right)$ using Lagrange's equation is given by which of the following ? (1) $x = \frac{15}{7}t^3 + \frac{6}{7}$ (2) $x = 5t^2 - 2$ (3) $x = 5t^3 + 3$ (4) $x = t^4 + 2$
49.	The solution of the linear integral equation $\phi(x) = (1+x)^2 + \int_{-1}^{1} (x\xi + x^2\xi^2)\,\phi(\xi)\,d\xi$, is (1) $\phi(x) = 1 + 6x + \frac{25}{9}x^2$ (2) $\phi(x) = 1 - 6x + \frac{5}{9}x^2$ (3) $\phi(x) = 1 + 3x - \frac{25}{9}x^2$ (4) None of these

Question No.	Questions
50.	The solution to the integral equation $\phi(x) = x + \int_0^x \sin(x-\xi)\phi(\xi)\,d\xi$ is given by (1) $x^2 + \frac{x^3}{3}$ (2) $x - \frac{x^3}{3!}$ (3) $x^2 - \frac{x^3}{3!}$ (4) $x + \frac{x^3}{3!}$
51.	The Laurent series expansion of $f(z) = \frac{z}{(z-1)(z-3)}$ for $0 < \lvert z-1 \rvert < 2$, is equal to (1) $\frac{-3}{4}\sum_{n=0}^{\infty}\frac{(z-1)^n}{2^n} - \frac{1}{2(z-1)}$ (2) $\frac{3}{4}\sum_{n=0}^{\infty}\frac{(z-1)^n}{2^n} - \frac{1}{4(z-1)}$ (3) $\frac{1}{4}\sum_{n=0}^{\infty}\frac{(z-1)^{-n}}{2^n} + \frac{(z-1)}{2}$ (4) None of these
52.	The residue of the function $f(z) = \frac{1}{(z^2+1)^3}$ at $z = i$, is (1) $\frac{3}{16i}$ (2) $\frac{3}{2i}$ (3) $\frac{4}{3i}$ (4) None of these

Question No.	Questions
53.	The fixed points of the Mobius transformation $w = \frac{(2+i)z-2}{z+i}$ are (1) $i, -i$ (2) $0, 1$ (3) $-1, 1$ (4) $1+i, 1-i$
54.	The image of circle $\|z-2\| = 2$ under the Mobius transformation $w = \frac{z}{z+1}$ is a circle in w-plane with (1) Centre $\left(\frac{1}{5}, 0\right)$ and radius $\frac{2}{5}$ (2) Centre $\left(\frac{2}{5}, 0\right)$ and radius $\frac{1}{5}$ (3) Centre $\left(\frac{1}{5}, 0\right)$ and radius $\frac{1}{5}$ (4) Centre $\left(\frac{2}{5}, 0\right)$ and radius $\frac{2}{5}$
55.	If 9 colours are used to paint 100 houses, then atleast ________ houses will be of the same colour. (1) 18 (2) 15 (3) 12 (4) 10
56.	The congruence $35x \equiv 14 \pmod{21}$ has (1) 5 solutions (2) 6 solutions (3) 7 solutions (4) No solution

Question No.	Questions
57.	The primitive roots of 3^2 are (1) 3, 7 (2) 2, 5 (3) 5, 7 (4) None of these
58.	Let G = {0, 1, 2, 3, 4, 5, 6, 7} be a group under the binary operation 'addition modulo 8', then the order of element 5, is (1) 1 (2) 2 (3) 4 (4) 8
59.	The centre of a non-abelian group of order 343 always has _______ elements in its centre. (1) 3 (2) 7 (3) 5 (4) None of these
60.	Let G be a group of order 20449. Then (1) G has only one Sylow-11 subgroup (2) G has only two Sylow-11 subgroups (3) G has only four Sylow-11 subgroups (4) None of these

Question No.	Questions
61.	The resolvent kernel for the integral equation $\phi(x) = 29 + 6x + \int_0^x [5 - 6(x-\xi)]\,\phi(\xi)\,d\xi$, is (1) $9\,e^{3(x-\xi)} - 4\,e^{2(x-\xi)}$ (2) $9\,e^{2(x-\xi)} - 4\,e^{3(x-\xi)}$ (3) $9\,e^{3(x-\xi)} - e^{-2(x-\xi)}$ (4) None of these
62.	Consider the two dimensional motion of a mass m attached to one end of a spring whose other end is fixed. Let k be the spring constant. The kinetic energy T and the potential energy V of the system are given by $T = \frac{1}{2} m(\dot{r}^2 + (r\dot{\theta})^2)$ and $V = \frac{1}{2} k r^2$, where $\dot{r} = \frac{dr}{dt}$ and $\dot{\theta} = \frac{d\theta}{dt}$ with t as time. Then which of the following statement is correct ? (1) r is an ignorable coordinate (2) θ is not an ignorable coordinate (3) $r^2\,\dot{\theta}$ remains constant throughout the motion (4) $r\,\dot{\theta}$ remains constant throughout the motion
63.	The Lagrange's equation for a simple pendulum is, (where symbols have their usual meanings) (1) $\dot{\theta} + \frac{g}{\ell}\sin\theta = 0$ (2) $\ddot{\theta} + \frac{g}{\ell}\sin\theta = 0$ (3) $\ddot{\theta} + \frac{g}{\ell}\tan\theta = 0$ (4) None of these

Question No.	Questions
64.	Let q_i and $\dot{q}_i$ respectively are the generalized coordinates and velocity of a mechanical system and p_i are its generalized momenta. If H is the Hamiltonian of the system, then Hamilton's equations of motion are (1) $\dot{q}_i = \frac{\partial H}{\partial p_i}, \dot{p}_i = \frac{\partial H}{\partial q_i}$ (2) $\dot{q}_i = -\frac{\partial H}{\partial p_i}, \dot{p}_i = \frac{\partial H}{\partial q_i}$ (3) $\dot{q}_i = \frac{\partial H}{\partial p_i}, \dot{p}_i = -\frac{\partial H}{\partial q_i}$ (4) $\dot{q}_i = -\frac{\partial H}{\partial p_i}, \dot{p}_i = -\frac{\partial H}{\partial q_i}$
65.	If $L = [L_1, L_2, L_3]$ is the vector moment of the external forces about a fixed point O, $\omega = [\omega_1, \omega_2, \omega_3]$ the angular velocity, and A, B, C are the principal moments of inertia, then Euler's dynamical equations of motion are (1) $L_1 = A\omega_1 - (B - C)\,\omega_2\omega_3, L_2 = B\omega_2 - (C - A)\,\omega_3\omega_1, L_3 = C\omega_3 - (A - B)\,\omega_1\,\omega_2$ (2) $L_1 = A\dot{\omega}_1 - (B - C)\,\omega_2\omega_3, L_2 = B\dot{\omega}_2 - (C - A)\,\omega_3\omega_1, L_3 = C\dot{\omega}_3 - (A - B)\,\omega_1\,\omega_2$ (3) $L_1 = A\dot{\omega}_1 + (B - C)\,\omega_2\omega_3, L_2 = B\dot{\omega}_2 + (C - A)\,\omega_3\omega_1, L_3 = C\dot{\omega}_3 + (A - B)\,\omega_1\,\omega_2$ (4) None of these
66.	An integer is chosen at random from two hundred digits. Then the probability that the integer is divisible is divisible by 6 or 8 is (1) 3/4 (2) 1/2 (3) 3/8 (4) 1/4

Question No.	Questions
67.	In a bolts factory, machines I, II and III manufacture respectively 25%, 35% and 40% of the total bolts. Of their total output 5%, 4% and 2% are respectively defective bolts. A bolt is drawn at random from the product. If the bolt drawn is found to be defective, what is the probability that it is manufactured by machine II ? (1) 0.41 (2) 0.27 (3) 0.13 (4) None of these
68.	Let X be a continuous random variable with probability density function (p.d.f.) defined as $f(x) = 6x(1-x), 0 \le x \le 1$. Then the value of number b such that $P(X < b) = P(X > b)$ is (1) 1/4 (2) 3/4 (3) 1/2 (4) None of these
69.	If X and Y are two random variables having joint density function given by $f(x, y) = \begin{cases} 6x^2y \ ; \ 0 < x < 1, 0 < y < 1 \\ 0 \ ; \ \text{otherwise} \end{cases}$ Then $P(X + Y < 1)$ is (1) 1/4 (2) 1/10 (3) 3/8 (4) None of these

Question No.	Questions
70.	For k = 1, 2, ..., 10, let the probability density function of the random variable X_k is given by $$f_{x_k}(x) = \begin{cases} \frac{e^{-\frac{x}{k}}}{k}, & x > 0 \\ 0, & \text{otherwise} \end{cases}$$ Then the value of $E\left(\sum_{k=1}^{10} k X_k\right)$ is equal to (1) 385 (2) 256 (3) 144 (4) 110
71.	If 2% of the items manufactured by a factory are defective, then the probability that there are 3 defective items in a sample of 100 items is (1) 0.48 (2) 0.33 (3) 0.27 (4) 0.18
72.	For a certain normal distribution, the first moment about 10 is 40 and the fourth moment about 50 is 48. Then the mean and standard deviation of the distribution respectively are (1) 20, 3 (2) 30, 4 (3) 50, 2 (4) None of these
73.	The characteristic function of χ^2–distribution with n degrees of freedom is (1) $(1-2it)^{n/2}$ (2) $(1+2it)^{n/2}$ (3) $(1-2it)^{-n/2}$ (4) None of these

Question No.	Questions
74.	If Tchebycheff's inequality for a random variable X with mean 12 is $P\{6 < X < 18\} \geq \frac{3}{4}$, then the standard deviation of X is (1) 2 (2) 3 (3) 8 (4) None of these
75.	The sum of all the elements of any row of the transition probability matrix of a Markov chain is (1) 0 (2) 1 (3) 2 (4) None of these
76.	Consider a discrete time Markov chain on the state space {1, 2, 3} with one-step transition probability matrix $\begin{bmatrix} 0 & 0.2 & 0.8 \\ 0.5 & 0 & 0.5 \\ 0.6 & 0.4 & 0 \end{bmatrix}$. Then the period of the Markov chain is (1) 3 (2) 2 (3) 1 (4) 0
77.	Let $\{X_t\}$ and $\{Y_t\}$ be two independent pure birth processes with birth rates λ_1 and λ_2 respectively. Let $Z_t = X_t + Y_t$. Then (1) $\{Z_t\}$ is not a pure birth process. (2) $\{Z_t\}$ is a pure birth process with birth rate $\lambda_1 + \lambda_2$. (3) $\{Z_t\}$ is a pure birth process with birth rate min (λ_1, λ_2). (4) $\{Z_t\}$ is a pure birth process with birth rate $\lambda_1 \lambda_2$.

Question No.	Questions
78.	Let X and Y be independent and identically distributed (i.i.d.) random variables uniformly distributed on (0, 4). Then P (X > Y | X < 2 Y) is (1) 2/3 (2) 5/6 (3) 1/4 (4) 1/3
79.	If X and Y are independent normal variates with zero expectations and variances σ_1^2 and σ_2^2, then $Z = \frac{XY}{\sqrt{X^2 + Y^2}}$ is normal with variance (1) $\sigma_z^2 = \frac{1}{\left(\frac{1}{\sigma_1^2} + \frac{1}{\sigma_2^2}\right)}$ (2) $\sigma_z^2 = \sigma_1^2 + \sigma_2^2$ (3) $\sigma_z^2 = \frac{1}{\sigma_1^2} + \frac{1}{\sigma_2^2}$ (4) None of these
80.	In testing $H : \mu = 100$ against $A : \mu \neq 100$ at the 10% level of significance, H is rejected if (1) 100 is contained in the 90% confidence interval (2) The value of the test statistic is in the acceptance region (3) The p-value is less than 0.10 (4) The p-value is greater than 0.10

Question No.	Questions
81.	Which of the following functions is not a function of bounded variation ? (1) $f(x) = \begin{cases} x\sin(\pi/x), & \text{if } 0 < x \le 1 \\ 0 & , \text{if } x = 0 \end{cases}$ (2) $f(x) = \begin{cases} x^2\sin(1/x), & \text{if } x \ne 0 \\ 0 & , \text{if } x = 0 \end{cases}$ (3) $f(x) = 3x^2 - 2x^3, -2 \le x \le 2$ (4) None of these
82.	Choose the incorrect statement. (1) The set of all irrational numbers in [0, 1] is measurable. (2) Every non-empty one set has positive measure. (3) Every subset of a set of measure zero is not of measure zero. (4) None of these
83.	The directional derivative of the function $\phi(x, y) = \frac{xy}{x^2 + y^2}$ at the point (0, 1) along a line making an angle of 30° with positive direction of x-axis is (1) $\frac{2}{\sqrt{3}}$ (2) $\frac{\sqrt{3}}{2}$ (3) $\sqrt{3}$ (4) None of these
84.	The metric space (R, d), where d is a usual metric, is (1) compact (2) disconnected (3) connected but not compact (4) compact and connected

Question No.	Questions
85.	In a metric space (0, 1] with usual metric $d(x, y) = \lvert x - y \rvert$, the sequence $< \frac{1}{n} >$ is a (1) Not a Cauchy sequence (2) Cauchy sequence but does not converge in (0, 1] (3) Cauchy sequence that is convergent in (0, 1] (4) None of these
86.	Let V be a vector space over R^3. Which one of the following is not a subspace of V ? (1) $\{(x, y, z) : 3x + y - z = 0, x, y, z \in R\}$ (2) $\{(x, y, z) : x + y - z = 0, 2x + 3y - z = 0, x, y, z \in R\}$ (3) $\{(x, y, z) : x - 3y + 4z = 0, x, y, z \in R\}$ (4) $\{(x, y, z) : x + y \geq 0, x, y, z \in R\}$
87.	The value of k for which the vector u = (1, k, 5) in V_3 (R) can be expressed as a linear combination of vectors v = (1, – 3, 2) and w = (2, – 1, 1) is (1) 3 (2) – 8 (3) – 2 (4) None of these

Question No.	Questions
88.	The dimension of the subspace W of R^4 generated by $\{(3, 8, -3, -5), (1, -2, 5, -3), (2, 3, 1, -4)\}$ is (1) 1 (2) 3 (3) 2 (4) None of these
89.	The rank of the matrix $\begin{bmatrix} 1 & 2 & 1 \\ -3 & -6 & -3 \\ 5 & 10 & 5 \end{bmatrix}$ is (1) 1 (2) 2 (3) 3 (4) None of these
90.	The system of equations $2x - 3y + z = 9$; $x + y + z = 6$; $x - y + z = 2$ has (1) a unique solution (2) infinite solutions (3) no solution (4) none of these
91.	For the initial value problem (IVP) $y' = f(x, y)$, $y(0) = 0$, which of the following statement is true ? (1) $f(x, y) = \sqrt{xy}$ satisfies Lipschitz's condition and so IVP has unique solution. (2) $f(x, y) = \sqrt{xy}$ does not satisfy Lipschitz's condition and so IVP has no solution. (3) $f(x, y) = \|y\|$ satisfies Lipschitz's condition and so IVP has unique solution. (4) $f(x, y) = \|y\|$ does not satisfy Lipschitz's condition still the IVP has unique solution.

Question No.	Questions
92.	The solution of the differential equation $\frac{dy}{dx} = 2xy$, $y(0) = 1$ by Picard's method upto third approximation is (1) $1+x^2+\frac{x^4}{2}+\frac{x^6}{6}$ (2) $1+x^2+\frac{3x^4}{2}+\frac{x^6}{6}$ (3) $1+x^2+\frac{x^4}{4}+\frac{x^6}{6}$ (4) None of these
93.	Using method of variation of parameters, the solution of the differential equation $y'' - 2y' = e^x \sin x$, is (1) $y = c_1 + c_2 e^{2x} - \frac{1}{2} e^x \sin x$ (2) $y = c_1 e^x + c_2 e^{-x} - \frac{1}{2} e^x \sin x$ (3) $y = c_1 + c_2 e^x + \frac{1}{2} e^x \sin x$ (4) None of these
94.	Let n be non-negative integer. The eigen values of the Sturm-Liouville problem $y'' + \lambda y = 0$ with boundary conditions $y(0) = y(2\pi)$, $y'(0) = y'(2\pi)$ are (1) n (2) $n^2 \pi^2$ (3) $n\pi$ (4) n^2

Question No.	Questions
95.	Green's function of the boundary value problem $\frac{d^2u}{dx^2} + u = 0,\ u(0) = 0,\ u\left(\frac{\pi}{2}\right) = 0$ is given by (1) $G(x, \xi) = \cos\xi \sin x,\ 0 \le x < \xi$ (2) $G(x, \xi) = \cosh\xi \sinh x,\ 0 \le x < \xi$ (3) $G(x, \xi) = x(1 - \xi),\ 0 \le x < \xi$ (4) None of these
96.	The solution of Partial differential equation $xz\,p + yz\,q = x\,y$ is (1) $\phi(xy, yz - y^2) = 0$ (2) $\phi(x/y, z + y^2) = 0$ (3) $\phi(x/y, xy - z^2) = 0$ (4) None of these
97.	The integral surface for the Cauchy problem $\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y} = 1$ which passes through the circle $z = 0,\ x^2 + y^2 = 1$ is (1) $x^2 + y^2 + 2z^2 + 2zx - 2yz - 1 = 0$ (2) $x^2 + y^2 + 2z^2 + 2zx + 2yz - 1 = 0$ (3) $x^2 + y^2 + 2z^2 - 2zx - 2yz - 1 = 0$ (4) None of these
98.	The partial differential equation $(x+1)\frac{\partial^2 u}{\partial x^2} - 2(x+2)\frac{\partial^2 u}{\partial x\,\partial y} + (x+3)\frac{\partial^2 u}{\partial y^2} = 0$ is (1) Elliptic (2) Hyperbolic (3) Parabolic (4) None of these

Question No.	Questions
99.	Using method of separation of variables, the solution of Partial differential equation $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ subject to the boundary conditions : u (0, y) = sin y for all y and u (∞, y) = 0 for all y is given by (1) $u(x, y) = e^{-x} \sin y$ (2) $u(x, y) = e^{x} \sin y$ (3) $u(x, y) = e^{-2x} \sin y$ (4) None of these
100.	Let $u(x, t) = e^{iwx}\ v(t)$ with $v(0) = 1$ be a solution to $\frac{\partial u}{\partial t} = \frac{\partial^3 u}{\partial x^3}$. Then (1) $u(x, t) = e^{iw(x - w^2 t)}$ (2) $u(x, t) = e^{iwx - w^2 t}$ (3) $u(x, t) = e^{iw(x + w^2 t)}$ (4) $u(x, t) = e^{iw^3(x - t)}$

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(PHD/URS-EE-DEC.-2022)

Sr. No. 10052

Code **D**

MATHEMATICS

Time : 1¼ Hours | **Total Questions : 100** | **Max. Marks : 100**

Roll No. ________________ (in figure) ______________________________ (in words)

Name : ______________________ Father's Name : ______________________

Mother's Name : ______________________ Date of Examination : ______________________

(Signature of the candidate) (Signature of the Invigilator)

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Question No.	Questions
1.	Which of the following functions is not a function of bounded variation ? (1) $f(x) = \begin{cases} x \sin(\pi/x), & \text{if } 0 < x \le 1 \\ 0 & , \text{if } x = 0 \end{cases}$ (2) $f(x) = \begin{cases} x^2 \sin(1/x), & \text{if } x \ne 0 \\ 0 & , \text{if } x = 0 \end{cases}$ (3) $f(x) = 3x^2 - 2x^3, -2 \le x \le 2$ (4) None of these
2.	Choose the incorrect statement. (1) The set of all irrational numbers in [0, 1] is measurable. (2) Every non-empty one set has positive measure. (3) Every subset of a set of measure zero is not of measure zero. (4) None of these
3.	The directional derivative of the function $\phi(x, y) = \frac{xy}{x^2 + y^2}$ at the point (0, 1) along a line making an angle of 30° with positive direction of x-axis is (1) $\frac{2}{\sqrt{3}}$ (2) $\frac{\sqrt{3}}{2}$ (3) $\sqrt{3}$ (4) None of these
4.	The metric space (R, d), where d is a usual metric, is (1) compact (2) disconnected (3) connected but not compact (4) compact and connected

Question No.	Questions
5.	In a metric space (0, 1] with usual metric $d(x, y) = \lvert x - y \rvert$, the sequence $< \frac{1}{n} >$ is a (1) Not a Cauchy sequence (2) Cauchy sequence but does not converge in (0, 1] (3) Cauchy sequence that is convergent in (0, 1] (4) None of these
6.	Let V be a vector space over R^3. Which one of the following is not a subspace of V ? (1) $\{(x, y, z) : 3x + y - z = 0, x, y, z \in R\}$ (2) $\{(x, y, z) : x + y - z = 0, 2x + 3y - z = 0, x, y, z \in R\}$ (3) $\{(x, y, z) : x - 3y + 4z = 0, x, y, z \in R\}$ (4) $\{(x, y, z) : x + y \geq 0, x, y, z \in R\}$
7.	The value of k for which the vector $u = (1, k, 5)$ in $V_3(R)$ can be expressed as a linear combination of vectors $v = (1, -3, 2)$ and $w = (2, -1, 1)$ is (1) 3 (2) −8 (3) −2 (4) None of these
8.	The dimension of the subspace W of R^4 generated by $\{(3, 8, -3, -5), (1, -2, 5, -3), (2, 3, 1, -4)\}$ is (1) 1 (2) 3 (3) 2 (4) None of these

Question No.	Questions
9.	The rank of the matrix $\begin{bmatrix} 1 & 2 & 1 \\ -3 & -6 & -3 \\ 5 & 10 & 5 \end{bmatrix}$ is (1) 1 (2) 2 (3) 3 (4) None of these
10.	The system of equations $2x - 3y + z = 9$; $x + y + z = 6$; $x - y + z = 2$ has (1) a unique solution (2) infinite solutions (3) no solution (4) none of these
11.	Let p be the probability that a coin will fall head in a single toss in order to test $H_0 = p = \frac{1}{2}$ against $H_1 : p = \frac{3}{4}$. The coin is tossed 5 times and H_0 is rejected if more than 3 heads are obtained. Then the probability of type I error is (1) 1/16 (2) 3/16 (3) 5/16 (4) None of these
12.	Given the observations 0.8, 0.71, 0.9, 1.2, 1.68, 1.4, 0.88, 1.62 from the uniform distribution on $(\theta - 0.2, \theta + 0.8)$ with $-\infty < \theta < \infty$, which of the following is a maximum likelihood estimate for θ ? (1) 0.7 (2) 0.9 (3) 1.1 (4) 1.3
13.	If $X_1, X_2, X_3, \ldots\ldots, X_n$ is a random sample from a normal population $N(\mu, 1)$. Then $t = \frac{1}{n}\sum_{i=1}^{n} X_i^2$ is a unbiased estimator of (1) μ^2 (2) $\mu^2 - 1$ (3) $1 - \mu^2$ (4) $\mu^2 + 1$

Question No.	Questions
14.	Let $X_1, X_2, ..., X_n$ be a random sample of size n from a p-variate Normal distribution with mean μ and positive definite covariance matrix $\sum$. Choose the correct statement (1) $(X_1-\mu)'\sum^{-1}(X_1-\mu)$ has chi-square distribution with 1 d.f. (2) $\overline{X}\,\overline{X}'$ has Wishart distribution with p d.f. (3) $\sum_{i=1}^{n}(X_i-\mu)(X_i-\mu)'$ has Wishart distribution with n d.f. (4) X_1+X_2 and X_1-X_2 are independently distributed.
15.	In a trivariate distribution : $\sigma_1 = 2$, $\sigma_2 = \sigma_3 = 3$, $r_{12} = 0.7$, $r_{23} = r_{31} = 0.5$. Then $R_{1.23}$ is (1) 0.1423 (2) 0.7211 (3) 0.4892 (4) None of these
16.	The total number of all possible Latin squares of order 3 is (1) 12 (2) 9 (3) 6 (4) None of these
17.	The Mean time to failure (MTTF) for an exponential distribution with parameter λ is (1) λ (2) λ^2 (3) $1/\lambda$ (4) None of these

Question No.	Questions
18.	The maximum value of $Z = 2x + 3y$ subject to the constraints : $x + y \le 30$; $3 \le y \le 12$; $x - y \ge 0$; $0 \le x \le 20$, is (1) 72 (2) 60 (3) 49 (4) None of these
19.	Men arrive in a queue according to a Poisson process with rate λ_1 and women arrive in the same queue according to another Poisson process with rate λ_2. The arrivals of men and women are independent. The probability that the first arrival in the queue is a man is (1) $\frac{\lambda_1}{\lambda_1 + \lambda_2}$ (2) $\frac{\lambda_2}{\lambda_1 + \lambda_2}$ (3) $\frac{\lambda_1}{\lambda_2}$ (4) $\frac{\lambda_2}{\lambda_1}$
20.	Arrivals at a telephone booth are considered to be Poisson with an average time of 12 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 4 minutes. Then the probability that a person arriving at the booth will have to wait in the queue is (1) $\frac{2}{3}$ (2) $\frac{1}{3}$ (3) $\frac{1}{6}$ (4) None of these

Question No.	Questions
21.	The resolvent kernel for the integral equation $\phi(x) = 29 + 6x + \int_0^x [5 - 6(x-\xi)]\phi(\xi)\,d\xi$, is (1) $9e^{3(x-\xi)} - 4e^{2(x-\xi)}$ (2) $9e^{2(x-\xi)} - 4e^{3(x-\xi)}$ (3) $9e^{3(x-\xi)} - e^{-2(x-\xi)}$ (4) None of these
22.	Consider the two dimensional motion of a mass m attached to one end of a spring whose other end is fixed. Let k be the spring constant. The kinetic energy T and the potential energy V of the system are given by $T = \frac{1}{2} m (\dot{r}^2 + (r\dot{\theta})^2)$ and $V = \frac{1}{2} k r^2$, where $\dot{r} = \frac{dr}{dt}$ and $\dot{\theta} = \frac{d\theta}{dt}$ with t as time. Then which of the following statement is correct ? (1) r is an ignorable coordinate (2) θ is not an ignorable coordinate (3) $r^2\dot{\theta}$ remains constant throughout the motion (4) $r\dot{\theta}$ remains constant throughout the motion
23.	The Lagrange's equation for a simple pendulum is, (where symbols have their usual meanings) (1) $\dot{\theta} + \frac{g}{\ell}\sin\theta = 0$ (2) $\ddot{\theta} + \frac{g}{\ell}\sin\theta = 0$ (3) $\ddot{\theta} + \frac{g}{\ell}\tan\theta = 0$ (4) None of these

Question No.	Questions
24.	Let q_i and $\dot{q}_i$ respectively are the generalized coordinates and velocity of a mechanical system and p_i are its generalized momenta. If H is the Hamiltonian of the system, then Hamilton's equations of motion are (1) $\dot{q}_i = \frac{\partial H}{\partial p_i}, \dot{p}_i = \frac{\partial H}{\partial q_i}$ (2) $\dot{q}_i = -\frac{\partial H}{\partial p_i}, \dot{p}_i = \frac{\partial H}{\partial q_i}$ (3) $\dot{q}_i = \frac{\partial H}{\partial p_i}, \dot{p}_i = -\frac{\partial H}{\partial q_i}$ (4) $\dot{q}_i = -\frac{\partial H}{\partial p_i}, \dot{p}_i = -\frac{\partial H}{\partial q_i}$
25.	If $\mathbf{L} = [L_1, L_2, L_3]$ is the vector moment of the external forces about a fixed point O, $\omega = [\omega_1, \omega_2, \omega_3]$ the angular velocity, and A, B, C are the principal moments of inertia, then Euler's dynamical equations of motion are (1) $L_1 = A\omega_1 - (B - C)\,\omega_2\omega_3, L_2 = B\omega_2 - (C - A)\,\omega_3\omega_1, L_3 = C\omega_3 - (A - B)\,\omega_1\,\omega_2$ (2) $L_1 = A\dot{\omega}_1 - (B - C)\,\omega_2\omega_3, L_2 = B\dot{\omega}_2 - (C - A)\,\omega_3\omega_1, L_3 = C\dot{\omega}_3 - (A - B)\,\omega_1\,\omega_2$ (3) $L_1 = A\dot{\omega}_1 + (B - C)\,\omega_2\omega_3, L_2 = B\dot{\omega}_2 + (C - A)\,\omega_3\omega_1, L_3 = C\dot{\omega}_3 + (A - B)\,\omega_1\,\omega_2$ (4) None of these
26.	An integer is chosen at random from two hundred digits. Then the probability that the integer is divisible is divisible by 6 or 8 is (1) 3/4 (2) 1/2 (3) 3/8 (4) 1/4
27.	In a bolts factory, machines I, II and III manufacture respectively 25%, 35% and 40% of the total bolts. Of their total output 5%, 4% and 2% are respectively defective bolts. A bolt is drawn at random from the product. If the bolt drawn is found to be defective, what is the probability that it is manufactured by machine II ? (1) 0.41 (2) 0.27 (3) 0.13 (4) None of these

Question No.	Questions
28.	Let X be a continuous random variable with probability density function (p.d.f.) defined as $f(x) = 6x(1-x), 0 \le x \le 1$. Then the value of number b such that $P(X < b) = P(X > b)$ is (1) 1/4 (2) 3/4 (3) 1/2 (4) None of these
29.	If X and Y are two random variables having joint density function given by $$f(x, y) = \begin{cases} 6x^2y \; ; \; \theta < x < 1, 0 < y < 1 \\ \theta \; ; \; \text{otherwise} \end{cases}$$ Then $P(X + Y < 1)$ is (1) 1/4 (2) 1/10 (3) 3/8 (4) None of these
30.	For k = 1, 2, ..., 10, let the probability density function of the random variable X_k is given by $$f_{x_k}(x) = \begin{cases} \frac{e^{-\frac{x}{k}}}{k}, \; x > 0 \\ 0 \quad , \; \text{otherwise} \end{cases}$$ Then the value of $E\left(\sum_{k=1}^{10} k X_k\right)$ is equal to (1) 385 (2) 256 (3) 144 (4) 110

Question No.	Questions
31.	For the initial value problem (IVP) $y' = f(x, y)$, $y(0) = 0$, which of the following statement is true ? (1) $f(x, y) = \sqrt{xy}$ satisfies Lipschitz's condition and so IVP has unique solution. (2) $f(x, y) = \sqrt{xy}$ does not satisfy Lipschitz's condition and so IVP has no solution. (3) $f(x, y) = \|y\|$ satisfies Lipschitz's condition and so IVP has unique solution. (4) $f(x, y) = \|y\|$ does not satisfy Lipschitz's condition still the IVP has unique solution.
32.	The solution of the differential equation $\frac{dy}{dx} = 2xy$, $y(0) = 1$ by Picard's method upto third approximation is (1) $1 + x^2 + \frac{x^4}{2} + \frac{x^6}{6}$ (2) $1 + x^2 + \frac{3x^4}{2} + \frac{x^6}{6}$ (3) $1 + x^2 + \frac{x^4}{4} + \frac{x^6}{6}$ (4) None of these
33.	Using method of variation of parameters, the solution of the differential equation $y'' - 2y' = e^x \sin x$, is (1) $y = c_1 + c_2 e^{2x} - \frac{1}{2} e^x \sin x$ (2) $y = c_1 e^x + c_2 e^{-x} - \frac{1}{2} e^x \sin x$ (3) $y = c_1 + c_2 e^x + \frac{1}{2} e^x \sin x$ (4) None of these

Question No.	Questions
34.	Let n be non-negative integer. The eigen values of the Sturm-Liouville problem $y'' + \lambda y = 0$ with boundary conditions $y(0) = y(2\pi)$, $y'(0) = y'(2\pi)$ are (1) n (2) $n^2 \pi^2$ (3) $n\pi$ (4) n^2
35.	Green's function of the boundary value problem $\frac{d^2u}{dx^2} + u = 0,\ u(0) = 0,\ u\left(\frac{\pi}{2}\right) = 0$ is given by (1) $G(x, \xi) = \cos\xi \sin x,\ 0 \le x < \xi$ (2) $G(x, \xi) = \cosh\xi \sinh x,\ 0 \le x < \xi$ (3) $G(x, \xi) = x(1 - \xi),\ 0 \le x < \xi$ (4) None of these
36.	The solution of Partial differential equation $xz\,p + yz\,q = xy$ is (1) $\phi(xy, yz - y^2) = 0$ (2) $\phi(x/y, z + y^2) = 0$ (3) $\phi(x/y, xy - z^2) = 0$ (4) None of these
37.	The integral surface for the Cauchy problem $\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y} = 1$ which passes through the circle $z = 0$, $x^2 + y^2 = 1$ is (1) $x^2 + y^2 + 2z^2 + 2zx - 2yz - 1 = 0$ (2) $x^2 + y^2 + 2z^2 + 2zx + 2yz - 1 = 0$ (3) $x^2 + y^2 + 2z^2 - 2zx - 2yz - 1 = 0$ (4) None of these

Question No.	Questions
38.	The partial differential equation $(x+1)\frac{\partial^2 u}{\partial x^2} - 2(x+2)\frac{\partial^2 u}{\partial x \partial y} + (x+3)\frac{\partial^2 u}{\partial y^2} = 0$ is (1) Elliptic (2) Hyperbolic (3) Parabolic (4) None of these
39.	Using method of separation of variables, the solution of Partial differential equation $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ subject to the boundary conditions : $u(0, y) = \sin y$ for all y and $u(\infty, y) = 0$ for all y is given by (1) $u(x, y) = e^{-x} \sin y$ (2) $u(x, y) = e^{x} \sin y$ (3) $u(x, y) = e^{-2x} \sin y$ (4) None of these
40.	Let $u(x, t) = e^{iwx}\, v(t)$ with $v(0) = 1$ be a solution to $\frac{\partial u}{\partial t} = \frac{\partial^3 u}{\partial x^3}$. Then (1) $u(x, t) = e^{iw(x - w^2 t)}$ (2) $u(x, t) = e^{iwx - w^2 t}$ (3) $u(x, t) = e^{iw(x + w^2 t)}$ (4) $u(x, t) = e^{iw^3(x - t)}$

Question No.	Questions
41.	The Laurent series expansion of $f(z) = \frac{z}{(z-1)(z-3)}$ for $0 < \lvert z-1 \rvert < 2$, is equal to (1) $\frac{-3}{4}\sum_{n=0}^{\infty}\frac{(z-1)^n}{2^n} - \frac{1}{2(z-1)}$ (2) $\frac{3}{4}\sum_{n=0}^{\infty}\frac{(z-1)^n}{2^n} - \frac{1}{4(z-1)}$ (3) $\frac{1}{4}\sum_{n=0}^{\infty}\frac{(z-1)^{-n}}{2^n} + \frac{(z-1)}{2}$ (4) None of these
42.	The residue of the function $f(z) = \frac{1}{(z^2+1)^3}$ at $z = i$, is (1) $\frac{3}{16i}$ (2) $\frac{3}{2i}$ (3) $\frac{4}{3i}$ (4) None of these
43.	The fixed points of the Mobius transformation $w = \frac{(2+i)z-2}{z+i}$ are (1) $i, -i$ (2) $0, 1$ (3) $-1, 1$ (4) $1+i, 1-i$

Question No.	Questions
44.	The image of circle $\|z-2\|=2$ under the Mobius transformation $w=\frac{z}{z+1}$ is a circle in w-plane with (1) Centre $\left(\frac{1}{5},0\right)$ and radius $\frac{2}{5}$ (2) Centre $\left(\frac{2}{5},0\right)$ and radius $\frac{1}{5}$ (3) Centre $\left(\frac{1}{5},0\right)$ and radius $\frac{1}{5}$ (4) Centre $\left(\frac{2}{5},0\right)$ and radius $\frac{2}{5}$
45.	If 9 colours are used to paint 100 houses, then atleast ______ houses will be of the same colour. (1) 18 (2) 15 (3) 12 (4) 10
46.	The congruence $35x \equiv 14 \pmod{21}$ has (1) 5 solutions (2) 6 solutions (3) 7 solutions (4) No solution
47.	The primitive roots of 3^2 are (1) 3, 7 (2) 2, 5 (3) 5, 7 (4) None of these

Question No.	Questions
48.	Let G = {0, 1, 2, 3, 4, 5, 6, 7} be a group under the binary operation 'addition modulo 8', then the order of element 5, is (1) 1 (2) 2 (3) 4 (4) 8
49.	The centre of a non-abelian group of order 343 always has _______ elements in its centre. (1) 3 (2) 7 (3) 5 (4) None of these
50.	Let G be a group of order 20449. Then (1) G has only one Sylow-11 subgroup (2) G has only two Sylow-11 subgroups (3) G has only four Sylow-11 subgroups (4) None of these
51.	Consider the matrix $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$, then (1) A has no real eigen values. (2) A has both positive and negative real eigen values. (3) All real eigen values of A are positive. (4) All real eigen values of A are negative.

Question No.	Questions
52.	Which of the following is a linear transformation ? (1) $T(x, y) = (1 + x, y)$ for all $(x, y) \in R^2$ (2) $T(x, y) = (x, x + y)$ for all $(x, y) \in R^2$ (3) $T(x, y) = (x^2, y)$ for all $(x, y) \in R^2$ (4) None of these
53.	The matrix representing the linear transformation $T : R^2 \to R^2$ defined by $T(x_1, x_2) = (2x_2, 3x_1 - x_2)$ relative to the basis $\{(1, 3), (2, 5)\}$ is (1) $\begin{bmatrix} 30 & 48 \\ 18 & 29 \end{bmatrix}$ (2) $\begin{bmatrix} -30 & 48 \\ 18 & -29 \end{bmatrix}$ (3) $\begin{bmatrix} 30 & 48 \\ -18 & -29 \end{bmatrix}$ (4) $\begin{bmatrix} -30 & -48 \\ 18 & 29 \end{bmatrix}$
54.	Let C^3 be a complex inner product space. If the vectors $u_1 = (1, 2i, i)$, $u_2 = (0, 1 + i, 1)$, $u_3 = (2, 1 - i, i) \in C^3$, then the vector orthogonal to both u_1 and u_3 is (1) $(-3 + i, -i, 1 - 5i)$ (2) $(-3 + i, -i, 1 + 5i)$ (3) $(3 + i, -i, 1 + 5i)$ (4) None of these
55.	The quadratic form corresponding to symmetric matrix $\begin{bmatrix} 9 & 3 & -3 \\ 3 & 2 & -4 \\ -3 & -4 & 2 \end{bmatrix}$ is (1) $9x^2 - 2y^2 + 2z^2 - 6xy - 6xz - 8yz$ (2) $9x^2 + 2y^2 + 2z^2 + 6xy - 6xz - 8yz$ (3) $9x^2 + 2y^2 - 2z^2 + 6xy + 6xz + 8yz$ (4) None of these

Question No.	Questions
56.	The radius of convergence of the power series $\sum_{n=0}^{\infty} \frac{(n!)^2}{(2n)!} z^n$ is (1) 4 (2) 3 (3) 2 (4) None of these
57.	Which one of the following functions f (z), of the complex variable z, is analytic over the entire complex plane ? (1) $f(z) = \ln(z)$ (2) $f(z) = e^{1/z}$ (3) $f(z) = \frac{1}{1-z}$ (4) $f(z) = \cos z$
58.	If $u = (x-1)^3 - 3xy^2 + 3y^2$ is the real part of an analytic function $f(z) = u + iv$, then the imaginary part v of f (z) is (1) $3x^2y - 6xy - 3y + y^3 + c$ (2) $3x^2y + 6xy + 3y + y^3 + c$ (3) $3x^2y - 6xy + 3y - y^3 + c$ (4) None of these
59.	The value of the integral $\int_C \bar{z}\, dz$, from $z = 0$ to $z = 4 + 2i$ along the curve C given by $z = t^2 + it$, is equal to (1) $5 - \frac{8}{3}i$ (2) $10 - \frac{8}{3}i$ (3) $10 - \frac{4}{3}i$ (4) None of these

Question No.	Questions
60.	The value of the integral $\int_C \frac{e^{-z}}{z^2} dz$, where C is a unit circle about the origin, described in positive sense, is equal to (1) 0 (2) πi (3) $-2\pi i$ (4) None of these
61.	The non-isomorphic abelian groups of order 20 are (1) $Z_4, Z_2 \times Z_2 \times Z_5$ (2) $Z_8, Z_2 \times Z_5$ (3) $Z_4 \times Z_5, Z_2 \times Z_2 \times Z_5$ (4) None of these
62.	Let Z [x] be the ring of polynomials over the ring of integers. Then (1) the ideal <x> is a prime ideal but not a maximal ideal. (2) the ideal <x> is not a prime ideal but a maximal ideal. (3) the ideal <x> is a prme ideal as well as a maximal ideal. (4) the ideal <x> is neither a prime ideal nor a maximal ideal.
63.	Which of the following is not a unique factorization domain ? (1) A Euclidean ring. (2) The ring < Z, +, . > of integers. (3) $Z[\sqrt{-5}]$ (4) None of these

Question No.	Questions
64.	Which one of the following polynomial is irreducible over the field Q of rational numbers ? (1) $2x^5 + 15x^3 + 3x + 6$ (2) $x^3 + 3x + 1$ (3) $8x^3 - 6x - 1$ (4) All of the above
65.	The degree of splitting field of $x^4 - x^2 - 2$ over the field Q of rational numbers, is (1) 3 (2) 4 (3) 2 (4) None of these
66.	Let F be a finite field and let K/F be a field extension of degree 6. Then the Galois group of K/F is isomorphic to (1) the cyclic group of order 6 (2) the permutation group on {1, 2, 3} (3) the permutation group on {1, 2, 3, 4, 5, 6} (4) the permutation group on {1}
67.	Which of the following spaces is not separable ? (1) R with the trivial topology (2) The Cantor set as a subspace of R (3) R with the discrete topology (4) None of these

Question No.	Questions
68.	Which one of the following topological spaces is not compact ? (1) Indiscrete topological space (2) Infinite discrete topological space (3) A topological space with cofinite topology (4) None of these
69.	Let X be a topological space and U be a proper dense open subset of X. Then which of the following statement is true ? (1) If X is connected, then U is connected. (2) If X is compact, then U is compact. (3) If $X\setminus U$ is compact, then X is compact. (4) If X is compact, then $X\setminus U$ is compact.
70.	Let X and Y be two topological spaces and let $f : X \to Y$ be a continuous function. Then (1) $f^{-1}(K)$ is connected if $K \subset Y$ is connected (2) $f^{-1}(K)$ is compact if $K \subset Y$ is compact (3) $f(K)$ is connected if $K \subset X$ is connected (4) None of these.
71.	Using Newton Raphson's method, the smallest positive root of the equation $3x^3 - 9x^2 + 8 = 0$, lying between 1 and 2, is (1) 1.0327 (2) 1.2261 (3) 1.6514 (4) None of these

Question No.	Questions
72.	Using Gauss Elimination method, the solution of following equations $4x + 3y + 2z = 8$, $x + y + 2z = 7$, $3x + 2y + 4z = 13$ is given by (1) $x = -1, y = 2, z = 3$ (2) $x = 1, y = 2, z = 3$ (3) $x = -1, y = -2, z = 3$ (4) $x = 1, y = -2, z = 3$
73.	Given that (see table below) The value of third divided difference of the function f (x) is (1) 5 (2) 1 (3) -1 (4) -2
74.	Consider the data given below : (see table below) Using Simpson's one third rule, the value of $\int_0^8 f(x)\,dx$ is (1) 34.5 (2) 47.3 (3) 52.8 (4) 60.4

Table for Question 73:

x	3	7	9	10
f (x)	168	120	72	63

Table for Question 74:

x	0	1	2	3	4	5	6	7	8
f (x)	0	4.13	7.20	9.25	10.25	10.00	9.05	7.12	6.2

Question No.	Questions
75.	Given $\frac{dy}{dx} = -y$ with y (0) = 1. Then using Euler's method, the value of y (0.02) by taking step size h = 0.01, is (1) 3.6845 (2) 2.7862 (3) 0.9801 (4) 0.5401
76.	The Euler's equation corresponding to the functional $\int_0^{\pi} (y'^2 - y^2 + 4y\cos x)\,dx$ subject to y (0) = 0, y (π) = 0 is (1) $\frac{d^2y}{dx^2} + y = 2\sin x$ (2) $\frac{d^2y}{dx^2} + y = 2\cos x$ (3) $\frac{d^2y}{dx^2} - y = 2\tan x$ (4) None of these
77.	The extremal of the functional $I[y(x)] = \int_1^2 (y'^2 - 2xy)\,dx$ subject to y (1) = 0, y (2) = – 1 is (1) $y = \frac{1}{6}(x - x^3)$ (2) $y = x^2 - 1$ (3) $y = \frac{1}{6}(7x - x^3)$ (4) None of these

Question No.	Questions
78.	The extremal of $\int_1^2 \frac{\dot{x}^2}{t^3} dt$; x (1) = 3, x (2) = 18 $\left(\text{where } \dot{x} \equiv \frac{dx}{dt}\right)$ using Lagrange's equation is given by which of the following ?
	(1) $x = \frac{15}{7}t^3 + \frac{6}{7}$ (2) $x = 5t^2 - 2$
	(3) $x = 5t^3 + 3$ (4) $x = t^4 + 2$
79.	The solution of the linear integral equation $\phi(x) = (1+x)^2 + \int_{-1}^{1} (x\xi + x^2\xi^2)\, \phi(\xi)\, d\xi$, is
	(1) $\phi(x) = 1 + 6x + \frac{25}{9}x^2$ (2) $\phi(x) = 1 - 6x + \frac{5}{9}x^2$
	(3) $\phi(x) = 1 + 3x - \frac{25}{9}x^2$ (4) None of these
80.	The solution to the integral equation $\phi(x) = x + \int_0^x \sin(x-\xi)\, \phi(\xi)\, d\xi$ is given by
	(1) $x^2 + \frac{x^3}{3}$ (2) $x - \frac{x^3}{3!}$
	(3) $x^2 - \frac{x^3}{3!}$ (4) $x + \frac{x^3}{3!}$

Question No.	Questions
81.	The infimum and the supremum of the set $\left\{\frac{(-1)^n}{n} : n \in N\right\}$ are respectively (1) $1, \frac{-1}{2}$ (2) $-1, \frac{1}{2}$ (3) $-1, 0$ (4) None of these
82.	Which of the following sequence is divergent ? (1) $a_n = 1 + \frac{2}{n}$ (2) $b_n = \frac{3n-1}{1+2n}$ (3) $c_n = 1 + \frac{(-1)^n}{n}$ (4) $d_n = \sin n$
83.	Consider the statements : (a) The series $\frac{1}{3} - \frac{2}{5} + \frac{3}{7} - \frac{4}{9} + \ldots\ldots\ldots\ldots$ is convergent. (b) The series $1 + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \ldots\ldots\ldots\ldots$ is convergent. Then (1) Both the statements (a) and (b) are true (2) The statement (a) is true and (b) is false (3) The statement (a) is false and (b) is true (4) Neither (a) nor (b) is true

Question No.	Questions
84.	Every bounded sequence has at least one limit point. This represents (1) Archimedean Property (2) Heine-Borel theorem (3) Bolzano-Weierstress theorem (4) Denseness Property
85.	Let $f : [0, \infty) \to R$ be a function, where R denotes the set of all real numbers. Then which one of the following statements is true ? (1) If f is continuous and $\lim_{x\to\infty} f(x)$ is finite, then f is uniformly continuous. (2) If f is bounded and continuous, then f is uniformly continuous. (3) If f is uniformly continuous, then $\lim_{x\to\infty} f(x)$ exists. (4) None of these
86.	Which of the following is false ? (1) The sequence $\{f_n\}$, where $f_n(x) = \frac{1}{x+n}$, is uniformly convergent in any interval [0, b], b > 0. (2) The sequence $\{f_n\}$, where $f_n(x) = \frac{n^2x}{1+n^3x^2}$, is uniformly convergent on the interval [0, 1]. (3) The sequence $\{f_n\}$, where $f_n(x) = \tan^{-1} nx, x \geq 0$, is uniformly convergent in any interval [a, b], a > 0. (4) None of these

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Question No.	Questions
87.	For which of the following function, Rolle's theorem is not applicable ? (1) $f(x) = \cos 2x$ in $[-\pi/4, \pi/4]$ (2) $f(x) = \frac{\sin x}{e^x}$ in $[0, \pi]$ (3) $f(x) = x^3 - 6x^2 + 11x - 6$ in $[1, 3]$ (4) $f(x) = \|x\|$ in $[-1, 1]$
88.	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 U (f, P) is (1) 23/36 (2) 31/36 (3) 49/36 (4) None of these
89.	If a function f defined on [0, 1] as $f(x) = \begin{cases} \sin\left(\frac{1}{x}\right), & \text{if } x \text{ is irrational} \\ 0, & \text{otherwise} \end{cases}$, then (1) f is not bounded (2) f is R-integrable (3) f is not R-integrable since f is not bounded (4) f is not R-integrable since lower and upper integrals of f are unequal

Question No.	Questions
90.	Consider the following improper integrals $I_1 = \int_0^{\infty} \frac{\sin^2 x}{x^2} dx$ and $I_2 = \int_1^{\infty} \frac{x^3}{(1+x)^5} dx$, then (1) Both are divergent (2) I_1 converges but not I_2 (3) I_2 converges but not I_1 (4) Both are convergent
91.	If 2% of the items manufactured by a factory are defective, then the probability that there are 3 defective items in a sample of 100 items is (1) 0.48 (2) 0.33 (3) 0.27 (4) 0.18
92.	For a certain normal distribution, the first moment about 10 is 40 and the fourth moment about 50 is 48. Then the mean and standard deviation of the distribution respectively are (1) 20, 3 (2) 30, 4 (3) 50, 2 (4) None of these
93.	The characteristic function of χ^2–distribution with n degrees of freedom is (1) $(1-2it)^{n/2}$ (2) $(1+2it)^{n/2}$ (3) $(1-2it)^{-n/2}$ (4) None of these
94.	If Tchebycheff's inequality for a random variable X with mean 12 is $P\{6 < X < 18\} \geq \frac{3}{4}$, then the standard deviation of X is (1) 2 (2) 3 (3) 8 (4) None of these

Question No.	Questions
95.	The sum of all the elements of any row of the transition probability matrix of a Markov chain is (1) 0 (2) 1 (3) 2 (4) None of these
96.	Consider a discrete time Markov chain on the state space {1, 2, 3} with one-step transition probability matrix $\begin{bmatrix} 0 & 0.2 & 0.8 \\ 0.5 & 0 & 0.5 \\ 0.6 & 0.4 & 0 \end{bmatrix}$. Then the period of the Markov chain is (1) 3 (2) 2 (3) 1 (4) 0
97.	Let $\{X_t\}$ and $\{Y_t\}$ be two independent pure birth processes with birth rates λ_1 and λ_2 respectively. Let $Z_t = X_t + Y_t$. Then (1) $\{Z_t\}$ is not a pure birth process. (2) $\{Z_t\}$ is a pure birth process with birth rate $\lambda_1 + \lambda_2$. (3) $\{Z_t\}$ is a pure birth process with birth rate min (λ_1, λ_2). (4) $\{Z_t\}$ is a pure birth process with birth rate $\lambda_1 \lambda_2$.
98.	Let X and Y be independent and identically distributed (i.i.d.) random variables uniformly distributed on (0, 4). Then P $(X > Y \mid X < 2Y)$ is (1) 2/3 (2) 5/6 (3) 1/4 (4) 1/3

Question No.	Questions
99.	If X and Y are independent normal variates with zero expectations and variances σ_1^2 and σ_2^2, then $Z = \frac{XY}{\sqrt{X^2 + Y^2}}$ is normal with variance (1) $\sigma_z^2 = \frac{1}{\left(\frac{1}{\sigma_1^2} + \frac{1}{\sigma_2^2}\right)}$ (2) $\sigma_z^2 = \sigma_1^2 + \sigma_2^2$ (3) $\sigma_z^2 = \frac{1}{\sigma_1^2} + \frac{1}{\sigma_2^2}$ (4) None of these
100.	In testing $H : \mu = 100$ against $A : \mu \neq 100$ at the 10% level of significance, H is rejected if (1) 100 is contained in the 90% confidence interval (2) The value of the test statistic is in the acceptance region (3) The p-value is less than 0.10 (4) The p-value is greater than 0.10

ANSWER KEYS OF MATHEMATICS FOR SESSION 2022-23				
Q. NO.	**A**	**B**	**C**	**D**
1	2	1	3	1
2	4	3	1	3
3	3	2	3	2
4	3	3	4	3
5	1	2	2	2
6	2	4	1	4
7	4	1	3	2
8	1	3	2	3
9	4	2	4	1
10	4	1	3	1
11	1	3	2	2
12	3	1	2	2
13	2	1	4	4
14	3	4	2	3
15	2	1	2	2
16	4	3	1	1
17	2	3	4	3
18	3	2	3	1
19	1	1	2	1
20	1	1	3	2
21	2	1	2	1
22	2	1	4	3
23	4	4	3	2
24	2	4	3	3
25	2	3	1	2
26	1	3	2	4
27	4	2	4	1
28	3	4	1	3
29	2	2	4	2
30	3	1	4	1
31	1	1	2	3
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33	4	2	4	1
34	4	3	3	4
35	3	2	2	1
36	3	4	1	3
37	2	2	3	3
38	4	3	1	2
39	2	1	1	1
40	1	1	2	1
41	3	2	2	1
42	1	2	1	1
43	3	4	2	4
44	4	3	4	4
45	2	2	3	3
46	1	1	2	3
47	3	3	1	2
48	2	1	4	4
49	4	1	1	2
50	3	2	4	1

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ANSWER KEYS OF MATHEMATICS FOR SESSION 2022-23				
Q. NO.	**A**	**B**	**C**	**D**
51	3	2	1	2
52	1	1	1	2
53	1	2	4	4
54	4	4	4	2
55	1	3	3	2
56	3	2	3	1
57	3	1	2	4
58	2	4	4	3
59	1	1	2	2
60	1	4	1	3
61	2	4	1	3
62	1	3	3	1
63	2	3	2	3
64	4	2	3	4
65	3	2	2	2
66	2	3	4	1
67	1	2	1	3
68	4	4	3	2
69	1	1	2	4
70	4	3	1	3
71	1	3	4	2
72	3	1	3	1
73	2	3	3	2
74	3	4	2	4
75	2	2	2	3
76	4	1	3	2
77	1	3	2	1
78	3	2	4	4
79	2	4	1	1
80	1	3	3	4
81	4	2	1	2
82	3	2	3	4
83	3	4	2	3
84	2	2	3	3
85	2	2	2	1
86	3	1	4	2
87	2	4	2	4
88	4	3	3	1
89	1	2	1	4
90	3	3	1	4
91	2	2	3	4
92	2	4	1	3
93	4	3	1	3
94	3	3	4	2
95	2	1	1	2
96	1	2	3	3
97	3	4	3	2
98	1	1	2	4
99	1	4	1	1
100	2	4	1	3

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