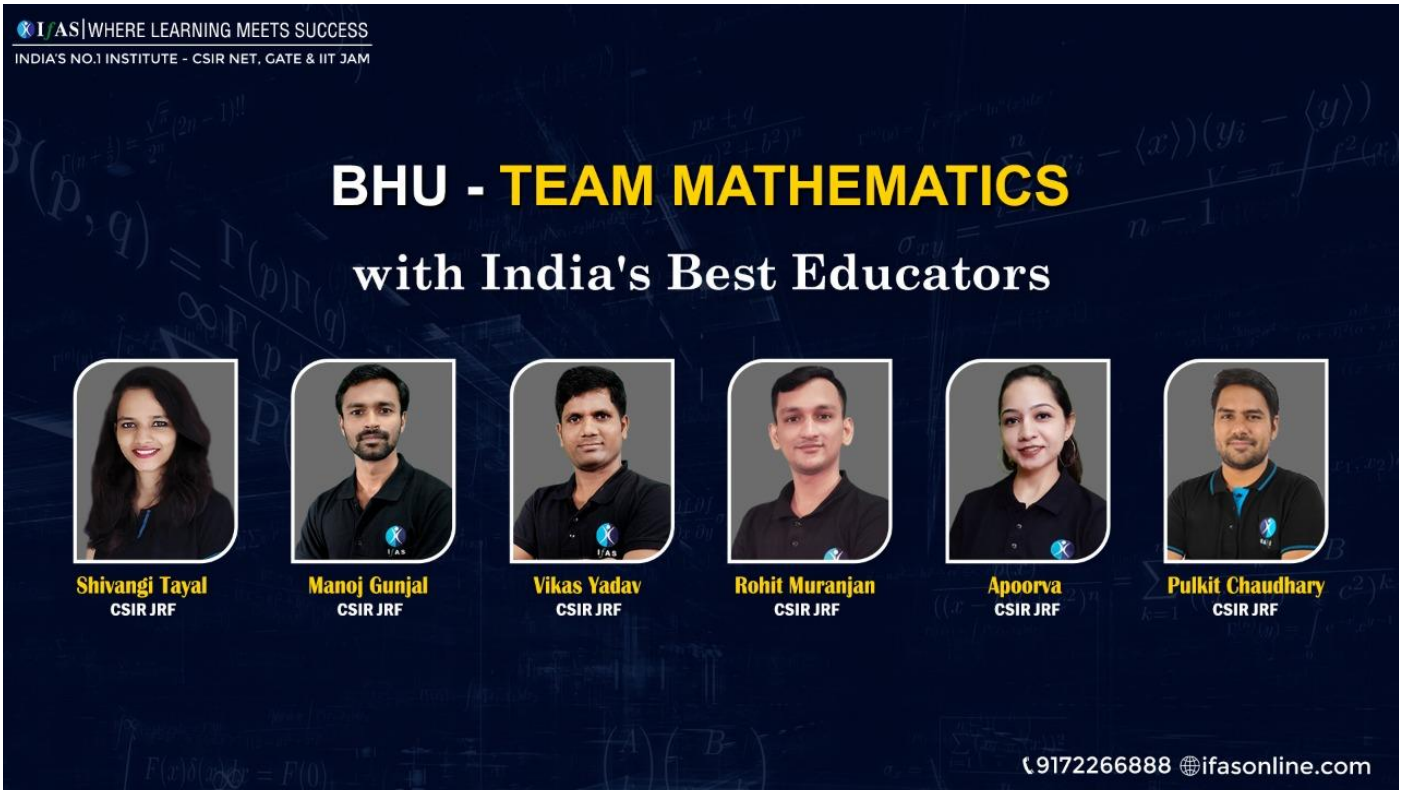
BHU MATHEMATICS 2019

IFAS SOLVED PAPER



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1. **The value of the $\lim_{n\to\infty} \frac{1}{n}\left(1 + 2^{1/2} + 3^{1/3} + \cdots + n^{1/n}\right)$ is:**
(a) 2
(b) ∞
(c) 0
(d) 1

2. **Let $p(x)$ be a continuous function such that general solution of the differential equation $x^2\frac{d^2y}{dx^2} - 2x(1+x)\frac{dy}{dx} + p(x)y = 0$ is $y(x) = c_1x + \frac{1}{2}c_2xe^{2x}$ where $c_1,\ c_2$ are constants, then:**
(a) $p(x) = 1 + x$
(b) $p(x) = 2\ (1 + x)$
(c) $p(x) = x^{2x}$
(d) $p(x) = x + 2$

3. **The following LPP**
Maximize $2x_1 + x_2 + 2x_3 + 9x_4$
Subject to: $x_1 + 2x_4 = 2$
$x_2 - x_3 + x_4 = 3$
$x_1, x_2, x_3, x_4 \geq 0$
has a:
(a) Degenerate solution
(b) Non-degenerate solution
(c) Bounded solution
(d) Unbounded solution

4. **The value of $\oint_C \frac{e^z}{z^2+9} dz$ where $C : |z| = 2$ and $z = x + iy$, is:**
(a) 0
(b) $4\pi i$
(c) $6\pi i$
(d) $2\pi i$

5. **The moment of Inertia of a circular disc of radius a and mass M, about the dismeter of the disc, is:**
(a) $\frac{1}{3}Ma^2$
(b) $\frac{2}{3}Ma^2$
(c) $\frac{1}{4}Ma^2$
(d) $\frac{1}{2}Ma^2$

6. **The equation of the plane passing through the point $(-1, 3, 1)$ and perpendicular to the line $2x + 3y + 4z = 5, 3x + 4y + 5z = 6$ is:**
(a) $4x + y + 2z - 1 = 0$
(b) $x - 2y + z + 6 = 0$
(c) $x - 2y + 2z + 5 = 0$
(d) $x + y + z - 3 = 0$

7. **The value of $\nabla + \Delta$ is"**
(a) $\Delta/\nabla + \nabla/\Delta$
(b) $\Delta/\nabla^2 + \nabla/\Delta^2$
(c) $\Delta/\nabla - \nabla/\Delta$
(d) $\Delta/\nabla^2 - \nabla/\Delta^2$

8. **If the sphere $x^2 + y^2 + z^2 = a^2$ touches the plane $lx + my + nz = p$, then:**
(a) $(l^2 + m^2 + n^2)\, p^2 = a^2$
(b) $l^2 + m^2 + n^2 = 1$
(c) $(l^2 + m^2 + n^2)\, p^2 / a^2$
(d) $l^2 + m^2 + n^2 = p^2$

9. **Consider the space $S = \{(x, y) |\ x, y \in Q\} \subseteq \mathbb{R}^2$, where Q is the set of normal numbers. Then:**
(a) S is closed in $\mathbb{R}^2$
(b) S is connected in $\mathbb{R}^2$
(c) S^c is closed in $\mathbb{R}^2$
(d) S^c is connected in $\mathbb{R}^2$

10. **Let $f : \mathbb{Z}[\sqrt{2}] \to \mathbb{Z}[\sqrt{3}]$ be a map defined by $f(a + b\sqrt{2}) = a + b\sqrt{3}$. In the following determine a correct answer:**
(a) f is neither a group homomorphism norm a ring homomorphism
(b) f is a ring homomorphism but not a group homomorphism
(c) f is a ring homomorphism
(d) f is a group homomorphism but not a ring homomorphism

11. **The differential equation $x^2 + \frac{d^2t}{dx^2} + x\frac{dy}{dx}x(x^2 - p^2)y = 0, p \geq 0$ is known as:**
(a) Bessel Equation
(b) Legendre Equation
(c) Euler Equation
(d) Lagrange Equation

12. **The optimal assignment of the problem**

	a	b	c	d
1	18	26	17	11
2	13	28	14	26
3	38	19	18	15
4	19	26	24	10

is:
(a) $1 \to a, 2 \to c, 3 \to d, 4 \to b$
(b) $1 \to c, 2 \to a, 3 \to b, 4 \to d$
(c) $1 \to d, 2 \to a, 3 \to d, 4 \to c$
(d) $1 \to d, 2 \to c, 3 \to d, 4 \to a$

13. **The convex hull of the set given below: $\{(x, y) : x, y \geq 0, x, y \leq 1\}$ is**
(a) Entire positive quadrant
(b) x- axis $\times$ y-axis
(c) Right half plane
(d) $[0, 1] \times [0, 1]$

14. **Consider the partial differential equation $\frac{\partial u}{\partial t} + \frac{\partial u}{\partial x} = x, x \in \mathbb{R}, t > 0$ with initial condition $u(x, 0) = \phi(x), x \in \mathbb{R}$. Then:**
(a) $u(x,t) = \phi(x - t)$
(b) $u(x,t) = \phi(x + t)$
(c) $u(x,t) = \phi(x - t) - \left(x - \frac{t}{2}\right) t$
(d) $u(x,t) = \phi(x - t) + x + \frac{t}{2}$

15. **Value of the integral $\int_0^1 \int_0^{1-x} e^{y/(x+y)} dx\, dy$ is:**
(a) $(e-1)$
(b) $(e+1)$
(c) $\frac{1}{2}(e-1)$
(d) $\frac{1}{2}(e+1)$

16. **Let $y(t)$ be the solution of initial value problem $\frac{d^2y}{dt^2} + \frac{dy}{dt} - 2y = 0$, $y(0) = b, \frac{dy}{dt}(0) = 2$. For which values of $b, \lim_{t\to\infty} y(t) = 0$:**
(a) -1
(b) 0
(c) 1
(d) There is no such value of b

17. **A uniform rod of mass m and length $2a$ can turn freely about a fixed end. The least angular velocity with which it must be started from the lowest position so that it may just make complete revolution is: (where g in the acceleration due to gravity)**
(a) $\sqrt{\frac{3a}{g}}$
(b) $\sqrt{\frac{a}{3g}}$
(c) $\sqrt{\frac{3g}{a}}$
(d) $\sqrt{\frac{g}{3a}}$

18. **The solution of the integral equation $\int_0^t \frac{y(u)}{\sqrt{t-u}} du = 1 + t$ is:**
(a) $\frac{1}{3\pi} t^{1/2}(6+3t)$
(b) $\frac{1}{3\pi} t^{-3/2}(6+2t)$
(c) $\frac{1}{3\pi} t^{1/2}(3+6t)$
(d) $\frac{1}{3\pi} t^{-1/2}(3+6t)$

19. **The number of elements of order 5 in the group $\mathbb{Z}_{15} \times \mathbb{Z}_5$ is:**
(a) 16
(b) 24
(c) 8
(d) 4

20. **Consider the differential equation $\frac{d^2y}{dt^2} + y = \operatorname{cosec} t$ by the method of variation of parameter, a solution is computed of the form $y(t) = f_1(t)\cos t + f_2(t)\sin t$, where f_1, f_2 are some functions, then:**
(a) $f_2(t) = \tan t$
(b) $f_1(t) = e^t$
(c) $f_1(t) = -t$
(d) $f_2(t) = t^3$

21. **The value of $\int_0^{1+i} (x^2 + iy)\, dz$ along the curve $y = x^2$ is:**
(a) $\frac{5}{6} i$
(b) $\frac{5i+1}{6}$
(c) $\frac{5i-1}{6}$
(d) $5i + 1$

22. **The evolute of the parabola $y^2 = 4ax$ is:**
(a) $27\ ay^2 = 4(x-2a)^3$
(b) $27\ ay^2 = 4(x-2a)^2$
(c) $4ay^2 = 27(x-2a)^3$
(d) $4ay^2 = 27(x-2a)^2$

23. **The value of $\oint_C \frac{dz}{z^2+4}$ where $C : |z+2i| = 1$ and $z = x+iy$, is:**
(a) $i\pi/2$
(b) $-\pi/2$
(c) $-i\pi/2$
(d) $\pi/2$

24. **The two balls of Billiards having same weight and velocities 6 cm/sec and -8cm/sec collide directly. If coefficient of restitution is 0.8, then their final velocities will be:**
(a) $\frac{21}{5}$ and $\frac{23}{5}$ cm/sec
(b) $\frac{22}{5}$ and $\frac{11}{5}$ cm/sec
(c) $\frac{-33}{5}$ and $\frac{23}{5}$ cm/sec
(d) $\frac{-11}{5}$ and $\frac{23}{5}$ cm/sec

25. **Which of the following curve in $\mathbb{R}^2$ is parametrized by its arc length?**
(a) $r(t) = \left(\frac{t}{\sqrt{2}}, \frac{t}{\sqrt{2}}\right)$
(b) $r(t) = (a\cos t, a\sin t), a \in \mathbb{R}^+$
(c) $r(t) = (t, t^2)$
(d) $r(t) = (a\cos t, a\sin t);\ a, b \in \mathbb{R}^+$

26. **If $f(x) = \sin g, g(x) = \cos x$ and $h(x) = \tan x$, then there exists at least one $c \in (\pi/6, \pi/4)$ such that:**
(a) $\begin{vmatrix} f'(c) & f(\pi/4) & f(\pi/6) \\ g(\pi/4) & g'(c) & g(\pi/6) \\ f(\pi/6) & g(\pi/4) & h'(c) \end{vmatrix} = 0$
(b) $\begin{vmatrix} f'(\pi/4) & g(\pi/6) & f'(c) \\ h(\pi/4) & g'(c) & h(\pi/6) \\ h'(c) & g(\pi/6) & g(\pi/4) \end{vmatrix} = 0$
(c) $\begin{vmatrix} h(\pi/6) & g(\pi/4) & h'(c) \\ g'(c) & g(\pi/6) & f'(c) \\ h(\pi/4) & h'(c) & g(\pi/4) \end{vmatrix} = 0$
(d) $\begin{vmatrix} f'(c) & f(\pi/6) & f(\pi/4) \\ g'(c) & g(\pi/6) & g(\pi/4) \\ h'(c) & h(\pi/6) & h(\pi/4) \end{vmatrix} = 0$

27. **The total number of surjective group homomorphism from the group $\mathbb{Z}_{20}$ to $\mathbb{Z}_8$**
(a) 8
(b) 0
(c) 2
(d) 4

28. If g_{ij} are components of metric tensor and $[k, ij]$ denotes Christoffel symbol of first kind then the value of $[k, ij] + [i + jk]$ is

(a) $\frac{\partial g_{ki}}{\partial x^j}$

(b) $\frac{\partial g_{jk}}{\partial x^i}$

(c) $\frac{\partial g_{ij}}{\partial x^k} + \frac{\partial g_{jk}}{\partial x^i}$

(d) $\frac{\partial g_{ik}}{\partial x^i}$

29. The differential equation of a simple harmonic motion, given by $x = A\cos(wt + \phi)$, where A and ϕ are constants, is:

(a) $\frac{d^2x}{dt^2} - w^2x = 0$

(b) $\frac{d^2w}{dt^2} - wx = 0$

(c) $\frac{d^2x}{dt^2} + w^2x = 0$

(d) $\frac{d^2x}{dt^2} + wx = 0$

30. If the plane $x + y + z = 5$ intersects the coordinate axes at points A, B, C respectively, then the area of the triangle ABC is:

(a) $\frac{25}{2}$

(b) $25\sqrt{3}$

(c) $25\sqrt{2}$

(d) $25\frac{\sqrt{3}}{2}$

31. Let $(\mathbb{Z}, \oplus)$ be a group. If the binary operation $\oplus$ is defined by $a \oplus b = a + b - 5$ for all $a, b \in \mathbb{Z}$, then the identity element of this group is:

(a) 1

(b) 0

(c) -5

(d) 5

32. The rank of matrix A, where $A = \begin{bmatrix} -1 & 1 & -2 & -1 \\ 1 & -1 & 2 & 1 \\ 4 & -4 & 4 & 2 \\ 3 & -3 & 4 & 2 \end{bmatrix}$ is:

(a) 1

(b) 2

(c) 4

(d) 3

33. If $x = 2, y = 3$ and $z = 1$ is a feasible solution of the following linear programming problem (LPP):

Max. $x + 2y + 4z$

Subject to $2x + y + 4z = 11$

$3x + y + 5z = 14$

$x, y, z \geq 0$

Then a basis feasible solution is:

(a) $x = 2, y = 0$ and $z = \frac{5}{2}$

(b) $x = 2, y = 0$ and $z = \frac{2}{5}$

(c) $x = \frac{1}{2}, y = 0$ and $z = \frac{2}{5}$

(d) $x = \frac{1}{2}, y = 0$ and $z = \frac{5}{2}$

34. **By using Lagrange's Mean Value theorem the value of $|\cos b - \cos a|$ is:**
(a) $\leq |b-a|$
(b) $\geq |b-a|$
(c) $\geq |b^2-a^2|$
(d) $> |b-a|$

35. **Solution of $f(x) - \int_0^1 (x+t)f(t)dt = \frac{3}{2}x - \frac{5}{6}$ is:**
(a) $f(x) = x+1$
(b) $f(x) = x-1$
(c) $f(x) = x$
(d) $f(x) = -x+1$

36. **The coplanar forces of magnitude $1, 2, 3\sqrt{3}$ and 4 Newtons are acting on a particle. The angle between first and second, second and third, third and fourth forces are $60°, 90°$ and $150°$ respectively. The magnitude of its resultant will be:**
(a) 3 Newton
(b) $\sqrt{2}$ Newton
(c) 2 Newton
(d) 1 Newton

37. **The initial value problem $\frac{dy}{dt} = \sqrt{|y|}; y(0) = 0$ has:**
(a) Two solutions
(b) Unique solution
(c) Infinitely many solution
(d) No solution

38. **Let $f : \mathbb{R} \to \mathbb{R}$ be a continuous map. Choose the correct statement.**
(a) f is bounded
(b) $f([0,1])$ is bounded
(c) $f^{-1}([0,1])$ is an open subset of $\mathbb{R}$
(d) The image of f is an open subset of $\mathbb{R}$

39. **Consider the set of points $(0,0), (1,0), (1,2), (1,1)$ and $(4,0)$. In expressing the boundary point as a convex combination of the extreme points, the values of λ_1, λ_2 and λ_3 are, respectively:**
(a) $\lambda_1 = \frac{3}{8}, \lambda_2 = \frac{1}{2}, \lambda_3 = \frac{1}{8}$
(b) $\lambda_1 = \frac{3}{8}, \lambda_2 = 0, \lambda_3 = \frac{1}{8}$
(c) $\lambda_1 = \frac{3}{8}, \lambda_2 = 0, \lambda_3 = \frac{1}{4}$
(d) $\lambda_1 = \frac{3}{4}, \lambda_2 = \frac{1}{4}, \lambda_3 = \frac{1}{2}$

40. **The value of $\nabla - \Delta$ is:**
(a) Δ/∇
(b) $\Delta\nabla$
(c) $-\Delta/\nabla$
(d) $-\Delta\nabla$

41. **In the journey from station A to station B, a train moves with uniform acceleration in first one fourth of its journey and last one fourth part with uniform acceleration and in middle half part with constant velocity. The average velocity of train is:**
(a) $\frac{3}{2} \times$ maximum velocity
(b) $\frac{1}{2} \times$ maximum velocity
(c) $\frac{1}{3} \times$ maximum velocity
(d) $\frac{3}{4} \times$ maximum velocity

42. **Let $f(t) = \begin{cases} -5, & -\pi \leq t \leq 0 \\ 5, & 0 < t \leq \pi \end{cases}$ be a periodic function of period 2π. Then the value of the Fourier coefficient a_0 is:**
(a) 5π
(b) 1
(c) 0
(d) 2π

43. **Let y_1 and y_2 be two linearly independent solutions of the differential equation $t\frac{d^2y}{dt^2} + \frac{dy}{dt} + ty = 0$, then the Wronskian $W(y_1, y_2)(t)$ is (where c is a constant):**
(a) $\frac{c}{t}$
(b) ct
(c) ce^{-t}
(d) ce^{t}

44. **The equation of the right circular cylinder whose guiding curve is the circle $x^2 + y^2 + z^2 - 9 = 0 = x - y + z - 3$ is:**
(a) $x^2 + y^2 + z^2 + xy - yz - zx - 9 = 0$
(b) $x^2 + y^2 + z^2 - xy - yz + zx - 9 = 0$
(c) $x^2 + y^2 + z^2 + xy - yz + zx - 9 = 0$
(d) $x^2 + y^2 + z^2 + xy + yz - zx - 9 = 0$

45. **If $u(t)$ is the map step function then the inverse Laplace transform of the function $\frac{e^{-5x}}{(s-2)^4}$ is:**
(a) $\frac{1}{6}(t+5)^3 e^{2(t+5)} u(t+5)$
(b) $\frac{1}{6}t^3 e^{2(t-5)} u(t-5)$
(c) $\frac{1}{6}(t-5)^3 e^{2t} u(t)$
(d) $\frac{1}{6}(t-5)^3 e^{2(t-5)} u(t-5)$

46. **For the following LP:**
Maximize $3x + 4y$
Subject to $x - y \leq -1$
$-x + y \leq 0$
$x, y \geq 0$
Which one of the following is true:
(a) LPP and its dual both have no solution
(b) LPP and its dual both have solution
(c) LPP has a solution, but the dual does not
(d) The dual has a solution but the LP does not

47. **The total number of ideals and maximal ideals of the ring $\mathbb{Z}_8$ are:**
(a) 4, 1
(b) 4, 0
(c) 1, 4
(d) 0, 4

48. **Which of the following surface can be treated as a surface of revolution about z:**
(a) $\frac{x^2}{a^2} + \frac{y^2}{a^2} + \frac{z^2}{c^2} = 1$
(b) $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$
(c) $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$
(d) $y^2 = 4ax$

49. **Let $T : P_2[x] \to \mathbb{R}^2$ be defined by $T(p(x)) = (p(0), p(1))$. Let $S_1 = \{1, x, x^2\}$ and $S_2\{(1,0),(0,1)\}$ be two basess of $P_2[x]$ and $\mathbb{R}^2$, respectively. The matrix of T with respect to bases of S_1 to S_2 is:**

(a) $\begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

(b) $\begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 1 \\ 0 & 1 \\ 0 & 1 \end{bmatrix}$

(d) $\begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 0 \end{bmatrix}$

50. **A particle describes the curve $r^2 = a^2 \cos 2\theta$ under a force to the pole. If the central acceleration is P, then:**

(a) $P \propto \frac{1}{r^3}$

(b) $P \propto \frac{1}{r^7}$

(c) $P \propto \frac{1}{r^4}$

(d) $P \propto \frac{1}{r^2}$

51. **The n th divided difference of the function $1/x$ based at the points $x_0, x_1, \dots, x_n$ is:**

(a) $\frac{(-1)^n}{x_0 x_1 \dots x_{n-1}}$

(b) $\frac{(-1)^n}{x_0 x_1 \dots x_n}$

(c) $\frac{1}{x_0 x_1 \dots x_n}$

(d) $\frac{(-1)^n}{x_1 \dots x_n}$

52. **The equation of the passes through x-axis and perpendicular to the line $\frac{x-1}{\cos\theta} = \frac{y+2}{\sin\theta} = \frac{z-3}{0}$ is:**

(a) $y \sin\theta + z \cos\theta = 0$

(b) $z = 0$

(c) $y = 0$

(d) $y = 1$

53. **If a particle moves in an ellipse of semi-major axis 'a' under a central force directed towards the focus of the ellipse, then the velocity v at any point of the path is given by:**

(a) $v^2 = \mu\left(\frac{2}{r} - \frac{1}{a}\right)$

(b) $v^2 = \frac{2\mu}{r}$

(c) $v^2 = \mu\left(\frac{2}{r^2} - \frac{1}{a}\right)$

(d) $v^2 = \mu\left(\frac{2}{r} + \frac{1}{a}\right)$

54. **One of the extreme points of the set $X = \{(x, y) : x - y \geq 0, x \leq 5, x + 2y \leq 4\}$ is:**

(a) $(1, 1)$

(b) $(0, 0)$

(c) $(1, 2)$

(d) $(5, 3)$

55. **The integral $\int_1^\infty \frac{\sin x}{s^p} dx$ converges iff:**

(a) $p > 1$

(b) $p > 0$

(c) $p < 0$

(d) $p < 1$

56. **The partial differential equation for the equation $2x = \frac{x^2}{a^2} + \frac{y^2}{b^2}$ (where a and b are parameters) is:**
(a) $2z = qx + py$
(b) $z = qx + py$
(c) $z = qy + px$
(d) $2z = px + qy$

57. **From a circular lamina whose radius is r, a small circular lamina is cut such that its diameter is a radius of the bigger lamina. The centre of the gravity of rest of the portion from the centre of the lamina will be:**
(a) $\frac{1}{5}r$
(b) $\frac{1}{7}r$
(c) $\frac{1}{6}r$
(d) $\frac{1}{3}r$

58. **The value of triple integral $\iiint \sqrt{1 - \frac{x^2}{a^2} - \frac{y^2}{b^2} - \frac{z^2}{c^2}}\, dx\, dy\, dz$ over the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ is:**
(a) $\pi^2 abc^2$
(b) $\frac{\pi ab}{4}$
(c) $\pi^2 abc$
(d) $\pi^2 \frac{abc}{4}$

59. **Which one of the following is not a subspace of $M_{n\times n}(\mathbb{R})$?**
(a) $W_3 = \{A \in M_{n\times n}(\mathbb{R}) |\ \text{trace}\ (A) = 0\}$
(b) $W_2 = \{A \in M_{n\times n}(\mathbb{R}) |\ \text{trace}\ (A) = 0\}$
(c) $W_1 = \{A \in M_{n\times n}(\mathbb{R}) |\ a_{11} = 0\}$
(d) $W_4 = \{A \in M_{n\times n}(\mathbb{R}) |\ A^t = A\}$

60. **Let (X, d) be a metric space and $A \subseteq X$, then which of the following is not correct?**
(a) $A^\circ \subseteq A$
(b) $A^\circ \cap B^\circ = (A \cup B)^\circ$
(c) $A \subseteq B \Rightarrow A^\circ \subseteq B^\circ$
(d) A° is open

61. **The Fourier Sine series of the function $f(t) = t, 0 < t < 2$ in a half range if:**
(a) $\sum_{n=1}^{\infty} \frac{4(-1)^{n-1}}{n\pi} \sin\left(\frac{n\pi t}{2}\right)$
(b) $\sum_{n=1}^{\infty} \frac{4(-1)^{n-1}}{\pi} \sin\left(\frac{n\pi t}{2}\right)$
(c) $\sum_{n=1}^{\infty} \frac{4(-1)^{n-1}}{n\pi} \cos\left(\frac{n\pi t}{2}\right)$
(d) $\sum_{n=1}^{\infty} \frac{4(-1)^{n-1}}{n^2\pi} \sin\left(\frac{n\pi t}{2}\right)$

62. **An acceleration of a particle in t seconds moving in a straight line is $(2t + 1)$ metre/sec2. If initial velocity is 4 metre/second, the velocity of particle after 2 seconds will be:**
(a) 15 metre/sec.
(b) 10 metre/sec.
(c) 5 metre/sec.
(d) 7.5 metre/sec.

63. **The value of $\int_0^\infty \frac{e^{-2t}-e^{-3t}}{t}\,dt$ is:**
(a) $\log_e\left(\frac{2}{3}\right)$
(b) $\log_e 2$
(c) $\log_e\left(\frac{3}{2}\right)$
(d) $\log_e 3$

64. **The shortest distance between z-axis and the line $x+t+z+3=0=3x+y+2z+2$ is:**
(a) $3\sqrt{3}$
(b) $2\sqrt{3}$
(c) $2\sqrt{2}$
(d) $3\sqrt{2}$

65. **Which one of the following sets is a convex set:**
(a) $\{(x,y):\ |x|\le 2, |y|\le 1\}$
(b) $\{(x,y):\ x^2+y-3\ge, x,y\ge 0\}$
(c) $\{(x,y):\ -x+y\ge 3,\ x-y\ge 3, x,y\ge 0\}$
(d) $\{(x,y):\ x^2+y^2=4\}$

66. **Let $\chi_A(x)$ denote the function which is 1 if $x\in A\,(A\subseteq\mathbb{R})$ and 0 otherwise. If $f(x)=\sum_{n=1}^{4}\frac{1}{n^6}\chi_{[0,n/4]}(x), x=[0,1]$, then $f(x)$:**
(a) Is a continuous function on $[0,1]$
(b) Is not Riemann integrable on $[0,1]$
(c) Is not monotone function on $[0,1]$
(d) Is monotone function on $[0,1]$

67. **A particle is thrown in vertical direction, the ratio of time by which particle will be at half of its maximum height is:**
(a) $1:(3+2\sqrt{2})$
(b) $1:(2+\sqrt{2})$
(c) $1:(2+2\sqrt{2})$
(d) $1:(4+\sqrt{3})$

68. **The group $S_3\times S_3$ has an element of order:**
(a) 4
(b) 18
(c) 9
(d) 6

69. **If $u=\frac{x}{y+z}+\frac{y}{z+x}+\frac{z}{x+y}$ then the value of $x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}+z\frac{\partial u}{\partial z}$ is:**
(a) 0
(b) $\log_e u$
(c) $2u\log_e u$
(d) $u\log_e u$

70. **For the following LPP**
Maximize $3x_1+5x_2$
Subject to: $x_1+x_2\le 4$,
$5x_1+3x_2\ge 8$
$x_1,x_2\ge 0$
The reduced cost coefficients for optimal solution are:
(a) $[0,4]$
(b) $[5,2]$
(c) $[4,0]$
(d) $[2,5]$

71. **The formula of $adj(T)$ of a linear operator T of a linear operator T on $\mathbb{C}^2$ defined by $T(\alpha,\beta) = (\alpha i + 2\beta, \alpha + \beta)$ is:**

(a) $T^*(\alpha,\beta) = (2\alpha + \beta, -\alpha i + \beta)$
(b) $T^*(\alpha,\beta) = (\alpha + \beta, \alpha i + 2\beta)$
(c) $T^*(\alpha,\beta) = (-\alpha i + \beta,\ 2\alpha + \beta)$
(d) $T^*(\alpha,\beta) = (-\alpha i + \beta,\ \alpha i + 2\beta)$

72. **Let $R = M_{2\times 2}(\mathbb{Z})$ be a ring and $S = \left\{\begin{pmatrix} a & 0 \\ 0 & a \end{pmatrix} : a \in \mathbb{Z}\right\}$ be a subset of R. Find the correct statement:**

(a) S is neither a subring nor an ideal
(b) S is an ideal but not a subring
(c) S is a subring but an ideal
(d) S is an ideal

73. **The smallest positive root of the equation $x^3 - 5x + 1 = 0$ correct to 2 decimal place is:**

(a) 0.25
(b) 0.29
(c) 0.20
(d) 0.30

74. **If the plane $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 0$ cuts the cone $xy + yz + zx = 0$ in perpendicular lines, then:**

(a) $\frac{1}{a} + \frac{1}{b} + \frac{1}{c} = 0$
(b) $a + b + c = 1$
(c) $\frac{1}{a} + \frac{1}{b} + \frac{1}{c} = 1$
(d) $a + b + c = 0$

75. **The value of the integral $\int_0^1 \log_e \sqrt{x}\ dx$ is:**

(a) $\frac{1}{2}\log_e 3\pi$
(b) $\frac{1}{3}\log_e 4\pi$
(c) $\frac{1}{2}\log_e 2\pi$
(d) $\frac{1}{2}\log_e 4\pi$

76. **The value of $\Delta^n f(x_i)$ is:**

(a) $\sum_{k=0}^{n}(-1)^k \frac{n!}{k!(n-k)!} f_{i+k}$

(b) $\sum_{k=0}^{n}(-1)^k \frac{n!}{k!(n-k)!} f_{i+n-k}$

(c) $\sum_{k=0}^{n}(-1)^k \frac{n!}{k!(n-k)!} f_{i-k}$

(d) $\sum_{k=0}^{n}(-1)^k \frac{n!}{k!(n-k)!} f_{i+n+k}$

77. **the locus of the point of point of intersection of three mutually perpendicular tangent planes to the surface $2x^2 - 3y^2 + 6z^2 = 1$**

(a) $x^2 + y^2 + z^2 = \frac{1}{3}$
(b) $x^2 + y^2 + z^2 = 1$
(c) $x^2 + y^2 + z^2 = \frac{2}{3}$
(d) $x^2 - y^2 + z^2 = \frac{2}{3}$

78. Using the Vogel's approximations method, the minimum transportation cost for the following transportation problem is:

Destination

Source	6	1	9	3	70
	11	5	2	8	55
	10	12	4	7	90
	85	35	50	45	

(a) 1060 Units
(b) 1016 Units
(c) 1100 Units
(d) 1160 Units

79. The Laplace transform of the function $f(t) = tJ_0$, where $J_0(t)$ is Bessel's function is:

(a) $\frac{s}{(s^2+1)^{3/2}}$
(b) $\frac{s}{(s^2+1)^{1/2}}$
(c) $\frac{1}{(s^2+1)^{3/2}}$
(d) $\frac{1}{(s^2+1)^{1/2}}$

80. The value of Bessel's function $J_{-1/2}(x)$ and $J_{1/2}(x)$ are:

(a) $\sqrt{\frac{\pi x}{2}}\cos x \ \sqrt{\frac{\pi x}{2}}\sin x$

(b) $\sqrt{\frac{\pi x}{2}}\sin x \ \sqrt{\frac{\pi x}{2}}\cos x$

(c) $\sqrt{\frac{2}{\pi x}}\sin x \ \sqrt{\frac{2}{\pi x}}\cos x$

(d) $\sqrt{\frac{2}{\pi x}}\cos x \ \sqrt{\frac{2}{\pi x}}\sin x$

81. By changing the order of integration, the integration $\int_0^1 \int_{\sqrt{y}}^{2-y} f(x,y)dy\,dx$ can be expressed as:

(a) $\int_0^2 \int_0^{x^2} f(x,y)dx\,dy + \int_0^2 \int_0^{2-x} f(x,y)dx\,dy$

(b) $\int_0^2 \int_0^{x^2} f(x,y)dx\,dy + \int_0^1 \int_0^{2-x} f(x,y)dx\,dy$

(c) $\int_0^1 \int_0^{x^2} f(x,y)dx\,dy + \int_0^2 \int_0^{2-x} f(x,y)dx\,dy$

(d) $\int_0^1 \int_0^{x^2} f(x,y)dx\,dy + \int_0^2 \int_0^{2-x} f(x,y)dx\,dy$

82. The dual of the following LPP:
Minimize $c^T x$
Subject to $Ax \le b$ is:

(a) Maximize $\lambda^T b$
Subject to $\lambda^t A \le c^T$
(b) Maximize $\lambda^T b$
Subject to $\lambda^t A \ge c^T$
(c) Maximize $\lambda^T b$
Subject to $\lambda^t A \ge c^T, \lambda \ge 0$
(d) Maximize $\lambda^T b$
Subject to $\lambda^t A = c^T, \lambda \le 0$

83. If the characteristic value of a 3×3 real matrix A are $-1, 1$ and 0, then:
(a) $A^2 = A$
(b) $A^3 = 0$
(c) $A^2 = I_3$
(d) $A^3 = A$

84. The locus of the pole of a given straight line with respect to a system of confocal conic is:
(a) A circle
(b) A line
(c) A pair of lines
(d) An ellipse

85. Which of the following statement is not correct?
(a) $f(z) = z^3$ is analaytic for any point z
(b) $f(z) = e^{\bar{z}}$ is not analytic at any point z
(c) $f(z) = \sin \bar{z}$ is analaytic for any point z
(d) $f(z) = \bar{z}$ is not analytic at any point z

86. If a line makes angles $\alpha, \beta, \gamma, \delta$ respectively with the four diagonals of a cube then the value of $\sin^2\alpha + \sin^2\beta + \sin^2\gamma + \sin^2\delta$ is:
(a) 1
(b) 2/3
(c) 4/3
(d) 8/3

87. Which of the following statement is not true?
(a) The series $\sum_{n=1}^{\infty} \left(1 + \frac{1}{\sqrt{n}}\right)^{-n^3/2}$ is divergent
(b) The series $\sum_{n=1}^{\infty} \frac{1}{n^2}$ is convergent
(c) The series $\sum_{n=1}^{\infty} 3^{-n-(-1)^n}$
(d) The series $\sum_{n=1}^{\infty} \frac{n^{n^2}}{(n+1)n^2}$ is convergent

88. Which of the following surface is disconnected?
(a) $x^2 + y^2 + z^2 = 1$
(b) $z = x^2 + y^2$
(c) $x^2 + y^2 - z^2 = 1$
(d) $x^2 - y^2 - z^2 = 1$

89. A particular solution of $\frac{d^3y}{dx^3} + \frac{d^3y}{dx^3} + \frac{dy}{dx} + y = x^5 - 2x^2 + x$ is:
(a) $x^5 + 5x^4 + 2x^2 - 125x + 121$
(b) $x^5 - 5x^4 + 125x - 121$
(c) $x^5 + 5x^4 - 2x^2 - 121$
(d) $x^5 - 5x^4 - 2x^2 + 125x - 121$

90. If the data points $(4\ 30)$ and $(6, 132)$ satisfying the function $y = f(x)$, then the value of $f(5)$, using Lagrange polynomial of degree 1, is:
(a) 80
(b) 81
(c) 75
(d) 70

91. Using Taylor's approximation about $x_0 = 0$ for the function $f(x) = e^{-x}(0 < x < 1)$, the minimum number of terms of the approximation to find the result which has error less than 10^{-10} is:

(a) $n \geq 14$
(b) $n \geq 10$
(c) $n \geq 7$
(d) $n \geq 12$

92. The direction cosines of the line $y - x = 0 = z$ are:

(a) $(1, 0,0)$
(b) $(1, 1,0)$
(c) $\left(\frac{1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}}\right)$
(d) $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0\right)$

93. A homogenous triangular lamina whose sides are 3, 4 and 5 cm is suspended by a rope from the mid point of longest side. That side will make an angle with the vertical equal to:

(a) $\cos^{-1}\left(\frac{7}{25}\right)$
(b) $\sin^{-1}\left(\frac{3}{17}\right)$
(c) $\sin^{-1}\left(\frac{2}{19}\right)$
(d) $\cos^{-1}\left(\frac{5}{17}\right)$

94. A cube function $y = f(x)$ satisfies the following data $f(0) = 1, f(1) = 4, f(3) = 40$ and $f(4) = 85$, then $f''(2)$ is:

(a) 12
(b) 14
(c) 18
(d) 16

95. For LPP
Minimize $(-2x_1 - x_2 - 7x_3 - 4x_4)$
Subject to $x_1 + x_2 + x_3 + x_4 = 26$
$x_1, x_2, x_3, x_4 \geq 0$
The optimal solution of the dual to above LPP is:

(a) $\lambda = -7$
(b) $\lambda = -4$
(c) $\lambda = -2$
(d) $\lambda = -1$

96. Which of the following convergent?

(a) $\sum_{n=3}^{\infty} \frac{1}{n(\log_e n)^{1/2}}$
(b) $\sum_{n=3}^{\infty} \frac{1}{n \log_e n (\log_e \log_e n)^2}$
(c) $\sum_{n=3}^{\infty} \frac{1}{n \log_e n \log_e \log_e n}$
(d) $\sum_{n=2}^{\infty} \frac{1}{n \log_e n}$

97. If $\frac{dy}{dx} = \frac{y-x}{y+x}, y(0) = 1$ then the Picard's method the value of $y(0.1)$ correct to 2 decimal place, is:

(a) 0.89
(b) 0.71
(c) 0.69
(d) 0.98

98. **The differential equation of the family of lines passing through the origin is:**
(a) $xdy - ydx = 0$
(b) $x^2dx + y^2dy = 0$
(c) $xdy + ydx = 0$
(d) $xdx + ydy = 0$

99. **The condition for convergence of Iterative formula $x_{k+1} = \phi(x_k)$ in interval $[a, b]$ is:**
(a) $|\phi(x)| < 1$
(b) $|\phi'(x)| > 1$
(c) $|\phi'(x)| < 1$
(d) $|\phi(x)| > 1$

100. **What is the minimum step size for $f(x) = \sin x$ in the interval $[1, 3]$ so that linear interpolation will be correct to four decimal places:**
(a) $h \leq 0.1$
(b) $h \leq 0.02$
(c) $h \leq 0.08$
(d) $h \leq 0.05$

101. **The sum of the series $\Delta - \frac{\Delta^2}{2} + \frac{\Delta^3}{3} - \cdots$ is:**
(a) hD
(b) $\Delta/\nabla - \Delta/\nabla$
(c) $h\Delta/\nabla$
(d) $D\Delta/\nabla$

102. **A heavy uniform rod AB, of weight w, is filled with any hinge at A and on downward end at B, a horizontal force F is applied. If in the state of equilibrium the rod makes an angle $60°$ with vertical, then the magnitude of force F will be:**
(a) $\frac{w}{4}\sqrt{5}$
(b) $\frac{w}{4}\sqrt{3}$
(c) $\frac{w}{7}\sqrt{2}$
(d) $\frac{w}{6}\sqrt{3}$

103. **The Laplace transform of the Dirac delta function $\delta(t-3)$ is:**
(a) e^{-5}
(b) e^{-3s}
(c) $\frac{e^{-3s}}{3s}$
(d) $\frac{e^{-3s}}{3}$

104. **A train of M kilograms is ascending in slope of 1m in n sec. The velocity of train is v m/sec and its acceleration is f m/sec^2. The horse power of engine is:**
(a) $\frac{Mv(nf+g)}{75ng}$
(b) $\frac{Mv(nf+g)}{ng}$
(c) $\frac{Mv(nf+g)}{100ng}$
(d) $\frac{Mv(nf+g)}{2ng}$

105. **Consider the equation $Ax = b$, where $A = \begin{bmatrix} 1 & 1 & 1 \\ 2 & 30 & \end{bmatrix}$ and $b = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, which one of the following is a basic solution?**

(a) $\begin{bmatrix} 0 \\ 1/2 \\ 1/2 \end{bmatrix}$

(b) $\begin{bmatrix} 2 \\ -1 \\ 0 \end{bmatrix}$

(c) $\begin{bmatrix} 2 \\ 0 \\ -1 \end{bmatrix}$

(d) $\begin{bmatrix} 0 \\ 1/3 \\ 2/3 \end{bmatrix}$

106. **If (r, θ) be the polar coordinates of the position of a particle moving along a plane curve at time t, then the transverse component of its velocity at time t is:**

(a) $\frac{d\theta}{dt}$

(b) $\frac{dr}{dt}$

(c) $\frac{1}{r}\frac{d}{dt}\left(r^2\frac{d\theta}{dt}\right)$

(d) $r\frac{d\theta}{dt}$

107. **The iterative function for finding the root of the equation $\cos(x) - xe^x = 0$ is:**

(a) $\phi(x) = \frac{1}{2}(\cos(x) - xe^x)$

(b) $\phi(x) = x + \frac{1}{2}(\cos(x) + xe^x)$

(c) $\phi(x) = x - \frac{1}{2}(\cos(x) - xe^x)$

(d) $\phi(x) = x + \frac{1}{2}(\cos(x) - xe^x)$

108. **If $f(x) = \begin{cases} 1, & x \in [0,1] \cap \mathbb{Q} \\ -1, & x \in [0,1] \cap (\mathbb{R} - \mathbb{Q}) \end{cases}$ then:**

(a) f is R-intergrable on $[0,1]$ and $\int_0^1 f(x)dx = -1$

(b) f is R-intergrable on $[0,1]$

(c) f is R-intergrable on $[0,1]$ and $\int_0^1 f(x)dx = 0$

(d) f is R-intergrable on $[0,1]$ and $\int_0^1 f(x)dx = 1$

109. **Let $T : \mathbb{R}^2 \to \mathbb{R}^2$ be a linear transformation defined by $T(x,y) = (x,0)$. The characteristic values of T are:**

(a) 0, 1

(b) 0, -1

(c) 1, -1

(d) 1, 2

110. **If $f(x,y) = \log_e\left(\cos^2\left(e^{x^2}\right)\right) + \sin(x+y)$ then $\frac{\partial}{\partial y}\frac{\partial}{\partial x}f(x,y)$ is:**

(a) $-\sin(x+y)$

(b) 0

(c) $\cos(x+y)$

(d) $\frac{\cos\left(e^{x^2}\right)-1}{1+\sin^2\left(e^{x^2}\right)} - \cos(x+y)$

111. Which one of the following is a correct statement?

(a) Dimension of $\mathbb{C}$ over $\mathbb{R}$ is 1

(b) Basis of zero vector space is $\{0\}$

(c) Dimension of $\mathbb{R}$ over $\mathbb{Q}$ is not finite

(d) The empty set ϕ is not linearly independent

112. The dual of the LPP is:
Minimize x
Subject to $x \leq 1$

(a) Maximize $(-\lambda)$
Subject to $\lambda = 1$
$\lambda \geq 0$

(b) Maximize λ
Subject to $\lambda = 1$
$\lambda \leq 0$

(c) Maximize λ
Subject to $\lambda \leq 1$

(e) Maximize λ
Subject to $\lambda = 1$
$\lambda \geq 0$

113. For a unique solution of the following system of linear equations, the value of λ and μ are:

(a) $\lambda = 3, \mu = 10$

(b) $\lambda \neq 3, \mu$ is arbitrary

(c) $\lambda \neq 3, \mu = 10$

(d) $\lambda \neq 3, \mu \neq 10$

114. A particle is thrown with the velocity v such that its range of horizontal plane is twice the maximum height obtained. Its range will be: (where g is the acceleration due to gravity)

(a) $\frac{4v^2}{3g}$

(b) $\frac{v^2}{7g}$

(c) $\frac{4v^2}{5g}$

(d) $\frac{2v^2}{3g}$

115. The orthogonal trajectories of the family of curve $y = ax^2$ is (a and c being constants):

(a) $\frac{x^2}{1} + \frac{y^2}{2} = c$

(b) $\frac{x^2}{2} + \frac{y^2}{3} = c$

(c) $\frac{x^2}{2} + \frac{y^2}{1} = c$

(d) $\frac{x^2}{3} + \frac{y^2}{2} = c$

116. If $u(t)$ is the unit step function and $\delta(t)$ is the Dirac delta function then the solution of the initial value problem $y'' + 16y = \delta(t-2), y(0) = 0, y'(0) = 0$ is:

(a) $\frac{1}{4}(\sin 4t)\, u(t-2)$

(b) $\frac{1}{4}(\sin 4(t-2))\, u(t-2)$

(c) $\frac{1}{4}(\sin 4t)\, u(t)$

(d) $\frac{1}{4}(\cos 4(t-2))\, u(t-2)$

117. Find the polynomial of degree 2 such that $f(0) = 1, f(1) = 3$ and $f(3) = 55$ is:

(a) $8x^2 + 6x - 1$
(b) $8x^2 - 6x - 1$
(c) $8x^2 - 6x + 1$
(d) $8x^2 + 6x + 1$

118. Which one of the following sets has no extreme point?

(a) $\{(x, y) : x \geq 0, y \geq 0\}$
(b) $\{(x, y) : x^2 + y^2 \leq 1\}$
(c) $\{(x, y) : x \geq \alpha, \alpha \in \mathbb{R}\}$
(d) $\{(x, y) : x \geq 0, 0 \leq y \leq z\}$

119. The values of $P_n(1)$ and $P_n(-1)$, where $P_n(x)$ is Legendra polynomial of degree n are:

(a) $(-1)^n, 1$
(b) $1, -1$
(c) $-1, 1$
(d) $1, (-1)^n$

120. Consider the wave equation $\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}, x \in \mathbb{R}, t > 0$ with conditions $u(x, 0) = 0$ and $\frac{\partial u}{\partial t}(x, 0) = \cos(x), x \in \mathbb{R}$. Then:

(a) $u(x, t) = \sin(x - t) - \sin(x + t)$
(b) $u(x, t) = \cos(x) \sin(t)$
(c) $u(x, t) = \cos(x + t)$
(d) $u(x, t) = \cos(t) \sin(x)$

ANSWER KEY

Q.NO.	KEY	Q.NO	KEY	Q.NO.	KEY	Q.NO	KEY
1	D	31	D	61	A	91	A
2	B	32	B	62	B	92	D
3	D	33	D	63	C	93	A
4	A	34	A	64	C	94	B
5	C	35	B	65	A	95	A
6	B	36	D	66	D	96	B
7	C	37	A	67	A	97	D
8	C	38	B	68	D	98	A
9	D	39	C	69	A	99	C
10	D	40	D	70	D	100	B
11	A	41	A	71	C	101	A
12	B	42	C	72	C	102	D
13	A	43	A	73	C	103	B
14	C	44	D	74	D	104	A
15	C	45	D	75	C	105	D
16	A	46	A	76	B	106	D
17	C	47	A	77	C	107	D
18	D	48	A	78	D	108	B
19	B	49	B	79	A	109	A
20	C	50	B	80	D	110	A
21	C	51	B	81	C	111	C
22	A	52	C	82	D	112	B
23	B	53	A	83	D	113	B
24	C	54	B	84	B	114	C
25	A	55	B	85	C	115	C
26	D	56	D	86	D	116	B
27	B	57	C	87	A	117	C
28	D	58	D	88	D	118	C
29	C	59	B	89	D	119	D
30	D	60	B	90	B	120	B

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