PUNJAB PUBLIC SERVICE COMMISSION

ROLL NO.

WRITTEN TEST FOR RECRUITMENT TO THE POSTS OF
LECTURER MATHEMATICS (BS-17)
(MALE/ FEMALE)
IN THE PUNJAB HIGHER EDUCATION DEPARTMENT-2015

TIME ALLOWED: TWO HOURS **MAXIMUM MARKS: 100**

INSTRUCTIONS

1. Write your allotted **Roll No.** in the top right corner of **QUESTION PAPER** and in the specified place of **ANSWER SHEET.**
2. Read **QUESTION PAPER** carefully and mark your answer on the **ANSWER SHEET.**
3. Each question has four options. Fill only one box that you think is the correct answer. Each question carries 1 mark. 0.25 mark will be deducted for each incorrect answer.
4. Instructions for filling box have been given on the Answer Sheet. Read them carefully before you attempt.
5. Read the instructions for filling your **ROLL NO.** and marking your answer on the **ANSWER SHEET** carefully before you start answering.
6. Sign the **Answer Sheet** in the box provided at the bottom corner.
7. Return both **Question Paper** and **Answer Sheet**, to the **Staff**, at the end of the test.
8. Use of Calculator is **not** allowed.

Q.1. $\int_{-4}^{0} \frac{t\,dt}{\sqrt{16-t^2}} =$ ________. (A) 0 (B) Divergent (C) -4 (D) 4

Q.2. The period of the function $A\cos\omega t + B\sin\omega t$ is________.
(A) $\frac{\omega}{2\pi}$ (B) $2\pi\omega$ (C) $\frac{\omega}{2\pi}$ (D) $\frac{2\pi}{\omega}$

Q.3. $A=(-4x-3y+az)\underline{i}+(bx+3y+5z)\underline{j}+(4x+cy+3z)\underline{k}$ is irrotational when a, b, c are________.
(A) $4, -3, 5$ (B) $4, 5, -3$ (C) $-3, 4, 5$ (D) $2, 3, 5$

Q.4. $V=(-4x-6y+3z)\underline{i}+(-2x+y-5z)\underline{j}+(5x+6y+az)\underline{k}$ is solenoidal for $a=$________.
(A) 1 (B) 2 (C) 3 (D) 4

Q.5. $\int_{(0,0)}^{(2,1)}(10x^4-2xy^3)dx-3x^2y^2dy$ along the path $x^4-6xy^3=4y^2$ is________.
(A) 56 (B) 60 (C) 62 (D) 64

Q.6. If S is the closed surface and v is the volume enclosed by S then $\iint_S \underline{r}\cdot\underline{n}\,ds=$________.
(A) v (B) 2v (C) 3v (D) 4v

Q.7. Centrifugal acceleration is________.
(A) $-\omega\times(\omega\times r)$ (B) $\omega\times(\omega\times r)$ (C) $\omega\cdot(\omega\times r)$ (D) $r\times(\omega\times r)$

Q.8. Number of degrees of freedom of two particles connected by a rigid rod moving freely in a plane is ________.
(A) 2 (B) 3 (C) 4 (D) 5

Q.9. The centroid of a uniform semicircular wire of radius a is________.
(A) $2a/\pi$ (B) $4a/\pi$ (C) a/π (D) $a/2\pi$

Q.10. Moment of inertia of a rectangular plate with sides a,b about an axis $\perp$ to plate and passing through vertex is________.
(A) $\frac{1}{3}Ma^2$ (B) $\frac{1}{3}Mb^2$ (C) $\frac{1}{3}M(a^2-b^2)$ (D) $\frac{1}{3}M(a^2+b^2)$

Q.11. Every bounded infinite set has at least one limit point, is the statement of ________.
(A) Hein-Borel Theorem (B) Weierstrass-Bolzano Theorem (C) Cantor's Intersection Theorem
(D) None of these

Q.12. $\lim_{z\to 0}\frac{\bar{z}}{z}=$ (A) $\frac{1+i}{1-i}$ (B) 1 (C) Does not exist (D) -1

Q.13. Cauchy-Riemann equations in polar form are________.
(A) $\frac{\partial u}{\partial r}=\frac{1}{r}\frac{\partial v}{\partial \theta}, \frac{\partial v}{\partial r}=\frac{-1}{r}\frac{\partial u}{\partial \theta}$ (B) $\frac{\partial u}{\partial r}=\frac{-1}{r}\frac{\partial v}{\partial \theta}, \frac{\partial v}{\partial r}=\frac{1}{r}\frac{\partial u}{\partial \theta}$ (C) $\frac{\partial u}{\partial r}=\frac{-1}{r}\frac{\partial v}{\partial \theta}, \frac{\partial v}{\partial r}=\frac{-1}{r}\frac{\partial u}{\partial \theta}$ (D) $\frac{\partial u}{\partial r}=\frac{1}{r}\frac{\partial v}{\partial \theta}, \frac{\partial v}{\partial r}=\frac{1}{r}\frac{\partial u}{\partial \theta}$

Q.14. Evaluate $\int_c \frac{z^2-z+1}{z-1}dz$, where C is the circle $|z|=\frac{1}{2}$:
(A) 1 (B) 2 (C) $\frac{1}{2}$ (D) 0

Q.15. The principal value of $(-i)^i$ is: (A) $e^{-\frac{\pi}{2}}$ (B) 1 (C) $e^{\frac{\pi}{2}}$ (D) e^{π}

Q.16. The Residue of $f(z)=\frac{z^2-2z}{(z+1)^2(z^2+4)}$ at z= 2i is________.
(A) $\frac{14}{25}$ (B) $\frac{7+i}{25}$ (C) $\frac{7-i}{25}$ (D) $\frac{-7-i}{25}$

Q.17. Radius of convergence of $\sum(3+4i)^n z^n$ is________.
(A) $\frac{1}{5}$ (B) 5 (C) 7 (D) ∞

Q.18. $\lim_{n\to\infty}(1+\frac{x}{n})^n$ is________. (A) 1 (B) 0 (C) e^x (D) e^n

Q.19. $U(x,y)=e^x\cos y$ is________.
(A) Harmonic (B) Analytic (C) Not Harmonic (D) None of these

Q.20. $\int_0^\infty \frac{\sin x}{x}dx=$________. (A) 0 (B) $\frac{-\pi}{2}$ (C) $\frac{\pi}{2}$ (D) π

Q.21. $Log(1+i)=$________.
(A) $\frac{1}{2}\ln 2+\frac{\pi i}{4}$ (B) $\frac{1}{2}\ln 2-\frac{\pi i}{4}$ (C) $\frac{1}{2}\ln 2-\frac{3\pi i}{4}$ (D) $\frac{1}{2}\ln 2+\frac{3\pi i}{4}$

Q.22. **Which of the following space is complete.** (A) Q (B) $]0,1]$ (C) Z (D) R

Q.23. **Least upper bound of** $\{\frac{1}{2},\frac{2}{3},\frac{3}{4},\dots\}$ **is:** (A) 1 (B) 0 (C) ∞ (D) $\frac{n}{n+1}$

Q.24. Error! Bookmark not defined. $\lim_{x\to1}\frac{x^x-x}{1-x+\ln x}$ **is :** (A) 2 (B) -2 (C) 1 (D) -1

Q.25. $\lim_{x\to0} x^{\sin x}$ **is** _________. (A) 0 (B) $\frac{1}{2}$ (C) e (D) ∞

Q.26. **Minimum and maximum values of** $f(x)=x^{\frac{2}{3}}(x^2-8)$ **in interval** $[-1,\frac{1}{2}]$ **are** (A) $-7, 0$ (B) 0,6 (C) 1,2 (D) $-2,3$

Q.27. $\int_0^1 \frac{4}{1+x^2}dx=$_________. (A) 0 (B) π (C) $\frac{4\pi}{3}$ (D) $-\pi$

Q.28. $\int_0^\pi cosec^2x\,dx=$_________. (A) 0 (B) 1 (C) -1 (D) ∞

Q.29. $\lim_{x\to0}\sin\frac{1}{x}=$_________. (A) does not exist (B) 1 (C) 0 (D) -1

Q.30. $\int_0^{\frac{3\pi}{4}}|\cos x|\,dx=$________. (A) $\frac{1}{\sqrt{2}}$ (B) $\frac{-1}{\sqrt{2}}$ (C) ∞ (D) $2-\frac{1}{\sqrt{2}}$

Q.31. $\sec\left(\tan^{-1}\frac{2}{3}\right)=$________. (A) $\frac{2}{\sqrt{13}}$ (B) $\frac{3}{\sqrt{13}}$ (C) $\frac{\sqrt{13}}{3}$ (D) $\frac{\sqrt{13}}{2}$

Q.32. **Which of the following is convergent series?** (A) $\sum\frac{1}{n^2}$ (B) $\sum\frac{1}{\sqrt{n}}$ (C) $\sum\frac{1}{n}$ (D) $\sum\frac{1}{n^{\frac{1}{3}}}$

Q.33. $x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}+\cdots$ **is the Maclaurin's series of** _________. (A) $\cos x$ (B) $\sin x$ (C) $\sinh x$ (D) $\cosh x$

Q.34. $\int_1^2\int_0^{y^{\frac{3}{2}}}\frac{x}{y^2}\,dxdy=$ _________. (A) $\frac{3}{4}$ (B) $\frac{7}{8}$ (C) $\frac{3}{2}$ (D) $\frac{1}{2}$

Q.35. **Domain of** $f(x)=\sqrt{1-x^2}$ **is** _________. (A) $x<1$ (B) $x>1$ (C) $|x|\le1$ (D) $|x|\ge1$

Q.36. **Domain of** $f(x)=\frac{1}{\sqrt{(1-x)(2-x)}}$ **is**_________. (A) $R\setminus[1,2]$ (B) $R\setminus\{1,2\}$ (C) $[1,2]$ (D) $]1,2[$

Q.37. $f:R\to(-1,1)$ defined by $f(x)=$ _______ **is bijective.** (A) $\frac{x}{1-|x|}$ (B) $\frac{x}{1+|x|}$ (C) $\frac{1}{1+|x|}$ (D) $\frac{x}{-1+|x|}$

Q.38. **Interval of convergence of** $\sum_{k=1}^{\infty}x^k$ **is** _________. (A) $]-1,1[$ (B) $[-1,1]$ (C) $(-\infty,+\infty)$ (D) $x=0$

Q.39. **Which of the following are open in the usual metric space *(R,d)*?** (A) Subsets of R (B) Union of open intervals (C) Intervals (D) Singleton subsets

Q.40. **Let A = (0,1]U(1,3] and R with usual metric space. Then** $A^0=$_________. (A) $A\setminus\{0\}$ (B) $A\setminus\{1\}$ (C) $A\setminus\{3\}$ (D) (0,1)U(1,3)

Q.41. **Let *A* be a finite subset of a metric space *X*. Then** $A^d=$_________. (A) singleton set (B) $\emptyset$ (C) A (D) $X\setminus A$

Q.42. **Let A be a finite subset of (X,d). Then A is** _________. (A) Open set (B) Open as well as closed (C) Closed set (D) neither open nor closed

Q.43. **If *Y* is a subset of *(X,d)* then** _________.
(A) Every open set in Y is open in X.
(B) Every open set in X is open in Y.
(C) O is open in Y $\Leftrightarrow$ O is open in X
(D) O is open $\Leftrightarrow O=Y\cap G$ where G is open in X.

Q.44. **Let** $f(x)=1+x^3$**. Then (0,0) is the point of** _________. (A) maximum value (B) minimum value (C) point of inflection (D) none of these

Q.45. **Number of elements in a co-finite topological space** (X,τ) **where** X**={s, t, u} is**_________. (A) 2 (B) 3 (C) 4 (D) 8

Q.46. **The boundary of a subset** $B=\{\frac{1}{n}: n\in N\}$ **of *(R, d)* is** _________. (A) B (B) $\{0\}$ (C) $B\cup\{0\}$ (D) $\emptyset$

Q.47. **The real line *R* is homeomorphic to** _________. (A) (0, 4) (B) $[-1,1]$ (C) Q (D) Z

Q.48. ***R* with co-finite topology is** _________. (A) T_0-space (B) T_1-space (C) T_1-space but not T_2-space (D) T_2-space

Q.49. **Let** $X=\{a, b, c\}$, $\tau=\{\emptyset, \{a\}, \{b\}, \{a,b\}, X\}$**. Then *X* is** _________. (A) T_1-space (B) Regular space (C) T_2-space (D) Normal space

Q.50. **Which of the following is connected in *R* with usual topology ?** (A) N (B) Q (C) (0,1] (D) Z

Q.51. **Which of the following topology is not totally disconnected ?** (A) {1} (B) Discrete space (C) *R* with usual topology (D) Q

Q.52. **Which of the following is nowhere dense in R**_________. (A) $R\setminus Z$ (B) Z (C) $\cup(n,n+1)$, $n\in Z$ (D) Q

Q.53. **Which of the following is dense in *R***_________. (A) N (B) Z (C) $R\setminus Z$ (D) Q

Q.54. $xy''+y'=0$ **has a solution** $y=\ln x$ **on interval**_________. (A) $(0,\infty)$ (B) $(-\infty,0)$ (C) $(-\infty,\infty)$ (D) $[0,\infty[$

Q.55. Which of the following is not linear ?
(A) $y' = (\sin x)y$ (B) $y' = (\sin y)x + e^x$ (C) $y' + xy = e^x y$ (D) $y' = 5$

Q.56. Solution of $y' = \frac{x+y}{x}$ is________.
(A) $y = ln|kx|$ (B) $y = ln|x|$ (C) $y = x\ ln\ |kx|$ (D) $y = ln\ |x| + k$

Q.57. Which of the following differential equation is not exact?
(A) $2xydx + (1+x^2)dy = 0$ (B) $ydx - xdy = 0$
(C) $y' = \frac{2+ye^{xy}}{2y-xe^{xy}}$ (D) $(x + \sin y)dx + (x\cos y - 2y)\,dy$

Q.58. Integrating factor for $y' + \left(\frac{4}{x}\right)y = x^4$ is________.
(A) x^4 (B) $ln\ x^4$ (C) $4\ ln\ |x|$ (D) $ln\ |x|$

Q.59. The area bounded by $y = 4 - x^2$ and X-axis is________.
(A) $\frac{4}{3}$ (B) $\frac{8}{3}$ (C) $\frac{16}{3}$ (D) $\frac{32}{3}$

Q.60. Which of the following is scalar?
(A) $(\underline{a}\cdot\underline{b})\underline{c}$ (B) $\underline{a}\cdot(\underline{b}\times\underline{c})$ (C) $\underline{a}\times(\underline{b}\times\underline{c})$ (D) $(\underline{a}\cdot\underline{b})(\underline{a}-\underline{a})$

Q.61. Projection of $\underline{a}$ on $\underline{b}$ is________.
(A) $\underline{a}\cdot\underline{b}$ (B) $\frac{\underline{a}}{|\underline{a}|}\cdot\underline{b}$ (C) $\underline{a}\cdot\frac{\underline{b}}{|\underline{b}|}$ (D) $\underline{a}\times\underline{b}$

Q.62. Which of the following is scalar quantity?
(A) Momentum (B) Magnetic field intensity (C) Specific heat (D) Moment of force

Q.63. A vector lying in the plane of $\underline{a}$ and $\underline{b}$ is ________.
(A) $(\underline{a}\times\underline{b})\times\underline{c}$ (B) $\underline{a}\times(\underline{b}\times\underline{c})$ (C) $(\underline{c}\times\underline{a})\times\underline{b}$ (D) $(\underline{c}\times\underline{b})\times\underline{a}$

Q.64. Let $\underline{t}$, $\underline{n}$ and $\underline{b}$ denote respectively the tanget ,principal normal and binormal vectors to the curve.Th osculating plane to the curve at P contains________.
(A) $\underline{t}$, $\underline{b}$ (B) $\underline{n}$, $\underline{b}$ (C) $\underline{t}$, $\underline{n}$ (D) $\underline{t}$, $\underline{n}$, $\underline{b}$

Q.65. Let $\underline{t}$, $\underline{n}$, and $\underline{b}$ be as in the above question. Then $\tau\underline{b} - k\underline{t}$ = ________.
(A) $\frac{d\underline{t}}{ds}$ (B) $-\frac{d\underline{n}}{ds}$ (C) $\frac{d\underline{b}}{ds}$ (D) $\frac{d}{ds}\left(\frac{(\underline{t}\times\underline{n})}{ds}\right)$

Q.66. Normal plane is perpendicular to________.
(A) $\underline{t}$ (B) $\underline{n}$ (C) $\underline{b}$ (D) $\underline{t}\times\underline{n}$

Q.67. $\underline{t}\times\underline{b}$ =________.
(A) $\underline{n}$ (B) $-\underline{n}$ (C) $\underline{n}\times\underline{b}$ (D) none of these

Q.68. $\{x/x\epsilon C: x^4 = 1\}$ is a________.
(A) Subgroup of (C\{0}, .) (B) Subgroup of (C, +) (C) Non cyclic group (D) Subgroup of (Q\{0}, .)

Q.69. R^3 under vector product forms a ________.
(A) group (B) monoid (C) semi-group (D) groupoid

Q.70. An element x of group G satisfying $x^2 = x$ is called ________.
(A) Involution (B) Idempotent (C) Transposition (D) Cycle

Q.71. $\frac{Z}{\langle n\rangle}$ is isomorphic to ________.
(A) nZ (B) $\langle n\rangle$ (C) Z_n (D) $\{0, \pm 2n, \pm 4n, \ldots\}$

Q.72. Let $G = \langle a: a^{12} = e\rangle$.Then G = ______.
(A) $\langle a^5\rangle$ (B) $\langle a^6\rangle$ (C) $\langle a^2\rangle$ (D) $\langle a^8\rangle$

Q.73. Let $G = \langle b: b^{17} = e\rangle$.Then G can be generated by ________.
(A) Any element of G (B) Any non identity element of G (C) b, b^{-1} are the only generators of G
(D) Identity

Q.74. If $G = \langle \alpha, \beta : \alpha^3 = \beta^2 = (\alpha\beta)^2 = e\rangle$ then $N_G(\{e, \beta\})$= ________.
(A) $\{e\}$ (B) $\{e, \beta, \alpha\beta\}$ (C) G (D) $\{e, \beta\}$

Q.75. Let $G = \langle\alpha, \beta: \alpha^4 = \beta^2 = (\alpha\beta)^2 = e\rangle$. Then Z(G)= ________.
(A) $\{e\}$ (B) $\{e, \alpha^2\}$ (C) $\{e, \alpha, \alpha^2, \alpha^3\}$ (D) G

Q.76. Which of the following is not true for an Abelian group G.?
(A) $[a, b] = e\ \forall\ a, b\epsilon G$ (B) G is simple group of order 60. (C) $G' = \{e\}$ (D) Z(G)=G

Q.77. Inner automorphisms of $Q = \{\pm 1, \pm i, \pm j, \pm k\}$ is ________.
(A) $\{e\}$ (B) $C_2 \times C_2$ (C) Q (D) C_4

Q.78. Number of conjugacy classes of a cyclic group of order 6 is ________.
(A) 1 (B) 2 (C) 3 (D) 6

Q.79. Number of non-isomorphic abelian groups of order 12 is ________.
(A) 1 (B) 2 (C) 3 (D) 4

Q.80. Order of sylow-2 subgroup of Q_8 is________.
(A) 1 (B) 2 (C) 4 (D) 8

Q.81. Which of the following is an ideal of R?
(A) Z (B) $\{0\}$ (C) C (D) Q

Q.82. Which of the following is not an integral domain?
(A) Z (B) Z_7 (C) Q (D) Set M_2 of 2×2 matrices with integer e

Q.83. Which of the following is a field?
(A) $\{a + b\sqrt{2} : a, b \in Q\}$ (B) $Q\setminus\{0\}$ (C) Z (D) Z_6

Q.84. Which of the following is not a vector space?
(A) $R(R)$ (B) $R(Q)$ (C) $R(C)$ (D) $C(Q)$

Q.85. Let $\varphi: Z \to Z_5$ be $\varphi(a) = a(mod\ 5)$.Then Ker(φ)= ________.
(A) $\{0\}$ (B) $\{0, \pm 5, \pm 10, \ldots\}$ (C) Z_5 (D) Z

Q.86. The number of proper ideals of Z_{17} is ________.
(A) 0 (B) 1 (C) 2 (D) 3

Q.87. Which of the following is a division Ring ?
(A) $(Z,+,.)$ (B) $(E,+,.)$ (C) $(Q,+,.)$ (D) $(z_6,\oplus_6,\odot_6)$

Q.88. $\int_{-1}^{2}(x+|x|)\,dx =$
(A) 0 (B) 4 (C) 2 (D) 6

Q.89. $x = 6$ in R^3 represents a
(A) point (B) Line (C) Plane (D) Space

Q.90. Kernel of $T: R^3 \to R^3$, where $T(x,y,z) = (x,y,\ 0)$, is
(A) Point (B) Line (C) Plane (D) Space

Q.91. Dimension of Hom$(R^3, R^4) =$
(A) 3 (B) 4 (C) 7 (D) 12

Q.92. Dimension of Hom$(M_{2,4},\ P_2(t)) =$ ________.
(A) 4 (B) 8 (C) 16 (D) 24

Q.93. A dice is thrown . The probability that the dots on the top are prime numbers or odd numbers is ________.
(A) $\frac{1}{3}$ (B) $\frac{2}{3}$ (C) 1 (D) $\frac{5}{6}$

Q.94. A coin is tossed 4 times in succession. The probability that at-least one head occurs is________.
(A) $\frac{1}{16}$ (B) $\frac{4}{16}$ (C) $\frac{12}{16}$ (D) $\frac{15}{16}$

Q.95. Number of necklaces made from 9 beads of different colors is ________.
(A) $\frac{8!}{2}$ (B) 8! (C) 7! (D) 9!

Q.96. Period of $3\cos\frac{x}{5}$ is ________.
(A) 2π (B) $\frac{2\pi}{5}$ (C) 6π (D) 10π

Q.97. Range of $\sec^{-1}x$ is ________.
(A) $[0,\ \pi]$ (B) $[0,\ \pi]\setminus\frac{\pi}{2}$ (C) $\left[\frac{-\pi}{2},\ \frac{\pi}{2}\right]$ (D) $\left[\frac{-\pi}{2},\ \frac{\pi}{2}\right]\setminus\{0\}$

Q.98. Solution set of $\sin x\cos x = \frac{\sqrt{3}}{4}$ is ________.
(A) $\left\{\frac{\pi}{6}+n\pi\right\}\cup\left\{\frac{\pi}{3}+n\pi\right\}$ (B) $\left\{\frac{\pi}{3}+2n\pi\right\}\cup\left\{\frac{2\pi}{3}+2n\pi\right\}$ (C) $\left\{\frac{\pi}{6}+2n\pi\right\}\cup\left\{\frac{5\pi}{6}+2n\pi\right\}$
(D) $\left\{\frac{\pi}{12}+n\pi\right\}\cup\left\{\frac{5\pi}{12}+n\pi\right\}$

Q.99. Which of the following is tautology?
(A) $p \to \sim q$ (B) $(p \to q) \cap (p\ \ q)$ (C) $p \to q \leftrightarrow \sim q \to \sim p$ (D) $p \cap \sim p$

Q.100. $f(z)=\frac{1}{z}$ is not uniformly continuous in the region ________.
(A) $0 \le |z| \le 1$ (B) $0 \le |z| < 1$ (C) $0 < |z| \le 1$ (D) $0 < |z| < 1$

FOR USE OF ROUGH WORK