Total No. of Printed Pages: **07**   No. of Questions : **50**

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PET 2024 (9015) Doctor of Philosophy(Mathematics)

(To be filled by the Candidate)

Candidate Seat Number
(As per Admit card)

OMR Sheet Number

Invigilator's signature with Date

Candidate's Seat No. in Words   :_____

Name of the Center   :_____

Paper Code & Name of Examination   : **9015 - Doctor of Philosophy(Mathematics)**

Date: **03/10/2024**   **PET 2024 - EXAMINATION**

Time: **One Hours**   Total Marks: **100**

Important Instructions for the candidate	**विद्यार्थ्यांसाठी महत्त्वाच्या सूचना**
1. Write your seat number and OMR Sheet number on the question paper in the earmarked space	1. परीक्षार्थींनी आपला आसन क्रमांक या पृष्ठावरील वरच्या कोप-यात तसेच आपणास दिलेल्या उत्तर पत्रिकेचा क्रमांक त्याखाली लिहावा.
2. This question paper carries Fifty (50) Multiple-choice type questions and each question carries 2 Marks	2. या प्रश्नपत्रिकेतील सर्व प्रश्न सोडवणे अनिवार्य आहे.
3. At the commencement of examination, the question paper will be given to the student.	3. परीक्षा सुरू झाल्यावर विद्यार्थ्याला प्रश्नपत्रिका दिली जाईल.
4. Each question has four alternative responses marked (A) (B) (C) and (D). You have to darken the circle as indicated below on the correct response against each question Example: where (C) is correct answer	4. प्रत्येक प्रश्नासाठी (A) (B) (C) (D) अशी चार विकल्प उत्तरे दिली आहेत, त्यातील योग्य उत्तराचा रकाना खाली दर्शविल्याप्रमाणे ठळकपणे काळा निळा करावा. उदा: जर (C) हे उत्तर योग्य असेल तर

(A)   (B)   ●   (D)   (A)   (B)   ●   (D)

5. Your responses to the answer are to be indicated in the OMR Sheet. If you mark at any place other than in the circle in the OMR Sheet it will not be evaluated.	5. या प्रश्नपत्रिकेतील प्रश्नांची उत्तरे ओएमआर उत्तर पत्रिकेतच दर्शवावीत इतर ठिकाणी लिहिलेली उत्तरे तपासली जाणार नाहीत.
6. Rough work is to be done at the end of this question paper.	6. प्रश्नपत्रिकाच्या शेवटी कोण्या जागेवरच कच्चे काम करावे
7. You have to return OMR answer sheet and question paper to the invigilator at the end of examination compulsorily and must not carry with you outside the examination hall.	7. परीक्षा संपल्यानंतर विद्यार्थ्यांनी मूळ ओ. एम. आर उत्तरपत्रिका पर्यवेक्षकाकडे परत करणे आवश्यक आहे तथापि प्रश्नपत्रिका व ओ. एम. आर. उत्तरपत्रिका आपल्याबरोबर नेण्यास विद्यार्थ्याला परवानगी नाही.
8. Use only Black / Blue ball point pen	8. फक्त काळ्या किंवा निळ्या बॉलपेनचाच वापर करावा
9. Use of any type of calculator or log table etc. is prohibited.	9. कॅल्क्युलेटर किंवा लॉग टेबल वापरण्यास परवानगी नाही
10. There is no negative marking for incorrect answers	10. चुकीच्या उत्तरासाठी गुण कपात केली जाणार नाही

Q. No.   **Question**

1. If a research is carried over a time then it is known as
   - **(A)** Experimental research
   - **(B)** Longitudinal research
   - **(C)** One time research
   - **(D)** Post facto research

2. Fundamental research is concerned with
   - **(A)** Generalization and formulation of theory
   - **(B)** Solution to immediate problem
   - **(C)** Marketing research
   - **(D)** None of the above

3. Conceptual research is
   - **(A)** An evaluation of process
   - **(B)** Related to some abstract idea or theory
   - **(C)** Relationship between control and non-control variables
   - **(D)** None of the above

4. Quantitative research is based on
   - **(A)** Study of human behavior
   - **(B)** Is study of natural phenomenon
   - **(C)** Abstract mathematical concept
   - **(D)** Quantitative measurement of some characteristics

5. In analytical research, researcher
   - **(A)** Use fact or information already available and analyze for critical evaluation
   - **(B)** Identify the trend of social change
   - **(C)** Use philosophy
   - **(D)** None of the above

6. Qualitative approach of research is concerned with
   - **(A)** Subjective assessment of attitudes
   - **(B)** Opinions
   - **(C)** Behaviour
   - **(D)** All of the above

7. Research Methodology is
   - **(A)** Method to generate the data
   - **(B)** Method of data acquisition
   - **(C)** Way to solve problems systematically
   - **(D)** Analysis of documents

8. Scientific method is based on certain basic postulates as
   - **(A)** It Relies on empirical evidence
   - **(B)** It utilizes relevant concepts
   - **(C)** It aims at formulating most general axioms
   - **(D)** All of the above

9. Published information is discussed in
   - **(A)** Research proposal
   - **(B)** Journal
   - **(C)** Literature review
   - **(D)** None of the above

10. Review of literature refers to
    - **(A)** Scaling technique for broad classification and comparisons
    - **(B)** Relating our ability to predict the outcome or estimate
    - **(C)** Most complex and abstract concept in research
    - **(D)** Extensive, exhaustive systematic survey of publication relevant to selected field

11. Synopsis is
    (A) A literature review
    (B) Concise outline survey of the contents
    (C) A survey research
    (D) Conclusion of research

12. An abstract is a
    (A) Separate section which includes introduction
    (B) Separate concise outline survey of contents
    (C) Separate entity, stand-alone without rest of the article
    (D) None of the above

13. According to UGC regulations Level 0 plagiarism refers to
    (A) Similarities above 60%
    (B) Similarities between 40% to 60%
    (C) Similarities between 10% to 40%
    (D) Similarities upto 10%

14. Plagiarism is
    (A) Citing reference to another paper
    (B) Not citing other persons work
    (C) Act of copying another person's work
    (D) None of the above

15. Research Purpose may be grouped into categories (i) exploration (ii) Description (iii) Diagnosis (iv)Experimentation
    (A) (i) only
    (B) (i) and (ii) only
    (C) (i), (ii) and (iii) only
    (D) (i), (ii), (iii) and (iv)

16. In research design experiment is
    (A) Survey of concerning literature
    (B) Means of obtaining information
    (C) Process of examining truth of statistical hypothesis
    (D) The objective of problem to be studied

17. Following is not a primary data type
    (A) Interview method
    (B) Data through Questionnaires
    (C) Observation method
    (D) Books magazine and newspaper

18. What is use of command \begin{center} in Latex
    (A) It creates tables
    (B) It underlines the text
    (C) It creates bold text
    (D) It centers the text

19. What is the purpose of the command \includegraphics{ } in LaTeX
    (A) It creates equation in the document
    (B) It creates references in the document
    (C) It includes image in the document
    (D) None of the above

20. What is the use of command \cite{} in LATEX
    (A) It sets text in bold
    (B) It sets text in italic
    (C) It creates new list
    (D) It adds a citation to a reference list

21. Existence statement is
    (A) A logical expression which is false
    (B) Logical expression with leading existential quantifier
    (C) hidden statement
    (D) None of the above

22. Predicate is defined to be any function that assumes
    (A) Positive value   (B) Negative value
    (C) Boolean value   (D) Infinite value

23. Properties of a function can be described as
    (A) Injective   (B) Surjective
    (C) Constant   (D) All of the above

24. Mathematical induction is a special form of mathematical argument and has following form
    (A) Well order principle   (B) The induction principle
    (C) The infinite descent method   (D) All of the above

25. Existence proofs are said to be (i) constructive if an explicit construction is given (ii) non constructive if no explicit construction is given
    (A) Only (i) Is true   (B) Only (ii) Is true
    (C) Both (i) and (ii) is true   (D) Both (i) and (ii) is false

26. For m=1,2,3,…, n=1,2,3,… and $s_{m,n} = \dfrac{m}{m+n}$.
    (A) $\lim\limits_{n\to\infty}\lim\limits_{m\to\infty} s_{m,n} = 0 \qquad \lim\limits_{m\to\infty}\lim\limits_{n\to\infty} s_{m,n} = 1$
    (B) $\lim\limits_{n\to\infty}\lim\limits_{m\to\infty} s_{m,n} = 0 \qquad \lim\limits_{m\to\infty}\lim\limits_{n\to\infty} s_{m,n} = 0$
    (C) $\lim\limits_{n\to\infty}\lim\limits_{m\to\infty} s_{m,n} = 1 \qquad \lim\limits_{m\to\infty}\lim\limits_{n\to\infty} s_{m,n} = 1$
    (D) $\lim\limits_{n\to\infty}\lim\limits_{m\to\infty} s_{m,n} = 1 \qquad \lim\limits_{m\to\infty}\lim\limits_{n\to\infty} s_{m,n} = 0$

27. Let $f \in R(\alpha)$ on [a,b],then
    (A) $\left|\displaystyle\int_a^b f\,d\alpha\right| > \displaystyle\int_a^b |f|\,d\alpha$
    (B) $\left|\displaystyle\int_a^b f\,d\alpha\right| \leq \displaystyle\int_a^b |f|\,d\alpha$
    (C) $\left|\displaystyle\int_a^b f\,d\alpha\right| \neq \displaystyle\int_a^b |f|\,d\alpha$
    (D) $\left|\displaystyle\int_a^b f\,d\alpha\right| \geq \displaystyle\int_a^b |f|\,d\alpha$

28. The four derivatives of the continuous function

$$f(x) = \begin{cases} ax\,\sin^2\dfrac{1}{x} + bx\cos^2\dfrac{1}{x}, & x > 0 \\ 0, & x = 0 \\ a'x\sin^2\dfrac{1}{x} + b'x\cos^2\dfrac{1}{x}, & x < 0 \end{cases}$$

Where a<b and a'<b'
    (A) $D^+f = b, \quad D_+f = a, \quad D^-f = a', \quad D_-f = b'$
    (B) $D^+f = a, \quad D_+f = b, \quad D^-f = a', \quad D_-f = b'$
    (C) $D^+f = b', \quad D_+f = a', \quad D^-f = a, \quad D_-f = b$
    (D) $D^+f = b', \quad D_+f = a, \quad D^-f = a', \quad D_-f = b$

29. $\int_0^1 \frac{x^{1/3}}{1-x} \log \frac{1}{x} dx = \dots$

(A) $9 \sum_{n=1}^{\infty} \frac{1}{(3n+1)^3}$

(B) $9 \sum_{n=1}^{\infty} \frac{1}{(3n+1)}$

(C) $9 \sum_{n=1}^{\infty} \frac{1}{(3n+1)^2}$

(D) $\sum_{n=1}^{\infty} \frac{1}{(3n+1)^2}$

30. If P^* is refinement of P then
(A) $L(P,f,\alpha) \geq L(P^*,f,\alpha)$
(B) $U(P^*,f,\alpha) \geq U(P,f,\alpha)$
(C) $L(P^*,f,\alpha) \geq U(P^*,f,\alpha)$
(D) None of the above

31. Which of the following function does not satisfy the Lipschitz's condition w.r.t. y on respective domain?
(A) f(x,y) = xy, x∈ (-∞,∞),y∈ (-∞,∞)
(B) f(x,y) = x sin(y), x∈ (-∞,∞),y∈ (-∞,∞)
(C) f(x,y) = $x^3 + y^3$, x∈ (-∞,∞),y∈ (-∞,∞)
(D) f(x,y) = $x^3 + y^3$, x∈ (-1,1),y∈ (-1,1).

32. A function v ∈ C [J_1,R] is said to be an upper function w.r.t. u'=g(t,u), u(t_0)=u_0 if v'$_+$(t) exists and satisfies the differential inequality :
(A) v'$_+$(t) < g(t,v(t))
(B) v'$_+$(t) > g(t, v(t))
(C) v'$_+$(t) ≤ g(t, v(t))
(D) v'$_+$(t) ≥ g(t, v(t))

33. The adjoint system of the system x' = A(t)x is given by :
(A) x' = -A(t)x
(B) x' = A^{-1}(t)x
(C) x' = -A^T(t)x
(D) x' = -A^{-1}(t)x

34. The Lagrange's identity for the pair of differential equations

(pu')' + qu = f(t) and (pv')' + qv = g(t) is given by :
(A) [p(uv'- vu')]' = gu - fv
(B) [p(uv'+ vu')]' = gu + fv
(C) p[(uv'-vu')]' = gu - fv
(D) p'[(uv'-vu')]' = gu - fv

35. The general form of Riccati differential equation is given by :
(A) a(t)r" + b(t)r'+ c(t)r = 0
(B) a(t)r^2 + b(t)r + c(t) = 0
(C) r" = a(t)r' + b(t)r + c(t)
(D) r' = a(t)r^2 + b(t)r + c(t)

36. The arguments of the complex number (1,0) is. . . . . .
(A) $\pi + 2k\pi, k \text{ is an integer}$
(B) 0
(C) π
(D) $2k\pi, k \text{ is an integer}$

37. The Cauchy-Riemann equations in polar coordinate form are. . . . .
(A) $ru_r = v_\theta; rv_r = -u_\theta$
(B) $u_x = v_y; v_x = -u_y$
(C) $u_x = -v_y; v_x = v_y$
(D) $ru_\theta = v_y; -rv_x = u_y$

38. If $a \in \mathbb{R}$ then the value of $\sqrt{-a^2}$ is. . . . . .

(A)	a	**(B)**	$-a$
(C)	ia	**(D)**	$\pm ia$

39. A necessary condition for the convergence of an infinite product $\prod_{n=1}^{\infty} a_n$ is, . . .

(A)	$\lim_{n\to\infty} a_n = 1$	**(B)**	$\lim_{n\to\infty} a_n = 0$
(C)	$\lim_{n\to\infty} a_n = \infty$	**(D)**	$\lim_{n\to\infty} a_n = -\infty$

40. An elementary function $E_p\left(\frac{z}{a}\right)$ has simple zeros at. . . . .

(A)	$z = 0$	**(B)**	$z = a$
(C)	$p = 0$	**(D)**	$p = a$

41. If p is a prime divisor of the order of a finite group G, then
- **(A)** G is cyclic
- **(B)** G is abelian
- **(C)** G has a cyclic subgroup of order p
- **(D)** G is simple

42. If D denotes derivative operation in the vector space V of polynomials of degree 2 or less than 2 over the field of real numbers, then the matrix of D with respect to basis $\{1, x, x^2\}$ is

(A) $\begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 2 \\ 0 & 0 & 0 \end{bmatrix}$ **(B)** $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 2 \\ 0 & 0 & 0 \end{bmatrix}$

(C) $\begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 2 \\ 0 & 2 & 0 \end{bmatrix}$ **(D)** $\begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 2 & 0 \end{bmatrix}$

43. If X is an infinite set with cofinite topology, then
- **(A)** X is compact and Hausdorff
- **(B)** X is connected and Hausdorff
- **(C)** X is compact but not connected
- **(D)** X is compact and connected

44. The conjugate space of a non-zero normed linear space is
- **(A)** Non-zero and Banach
- **(B)** Non-zero but not Banach
- **(C)** Banach but need not be non-zero
- **(D)** Neither Banach nor non-zero

45. The solution of the Volterra integral equation
$y(t) = \sinh t - 2 \int_0^t \sinh(t - x)\, y(x)\, dx$ is

(A)	$\sin t$	**(B)**	$\cos t$
(C)	$\sinh t$	**(D)**	$\cosh t$

46. The solution of the partial differential equation $xzp + yzq = xy$ is is
- **(A)** $\emptyset(x - y, y - z) = c_1$
- **(B)** $\emptyset(xyz) = c_2$
- **(C)** $\emptyset(xz, y) = c_3$
- **(D)** $\emptyset\left(\frac{x}{y}, \frac{y}{z}\right) = c_4$

47. The complete integral of the PDE $p^2y(1 + x^2) = qx^2$ is

    (A) $$z = \frac{1}{\sqrt{1 + x^2}} - \frac{1}{2}a^2y^2 + b$$

    (B) $$y = \frac{a}{\sqrt{1 + x^2}} + \frac{1}{2}a^2y^2 + b$$

    (C) $$z = \frac{a}{\sqrt{1 + x^2}} + \frac{1}{2}a^2y^2 + b$$

    (D) None of these

48. The complete integral of the equation $z = px + qy + f(p, q)$ is

    (A) $z = x + y + f(a, b)$

    (B) $z = axy + f(a, b)$

    (C) $z = ax + by + f(a, b)$

    (D) $z = ax + by$

49. Hamiltonian H is defined as

    (A) The total energy of the system

    (B) The difference in energy of the system

    (C) The product of energy of the system

    (D) All of these

50. The variational principle the line integral of some function between two end points is

    (A) Zero

    (B) Extremum

    (C) Infinite

    (D) One

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