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MPHDURS-EE-2013

SUBJECT : Mathematics

18/9/13

B

10150

Sr. No. ....

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

Candidate's Name ____________________ Date of Birth ____________________

Father's Name ____________________ Mother's Name ____________________

Roll No. (in figures) ____________________ (in words) ____________________

Date of Examination ____________________

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(Signature of the Candidate) (Signature of the Invigilator)

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1. ***All questions are compulsory and carry equal marks.***
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7. *Before answering the questions, the candidates should ensure that they have been supplied correct and complete booklet. Complaints, if any, regarding misprinting etc. will not be entertained* **30** *minutes after starting of the examination.*

1. The product of two odd permutations is :
   (1) even and odd (2) odd (3) even (4) none of these
2. A group has almost one composition series. This result is known as :
   (1) Cayley's theorem (2) Sylow's theorem
   (3) Lagrange's theorem (4) Jordan-Holder theorem
3. If every non-constant polynomial over a field F has all its roots in F, then F is :
   (1) Algebraically Closed Field (2) Prime Field
   (3) Perfect Field (4) None of the above
4. Let $R = F[x]$ be a polynomial ring over a field F. Then R is :
   (1) Artinian but not Noetherian (2) Artinian and Noetherian both
   (3) Neither Artinian nor Noetherian (4) Noetherian but not Artinian
5. Which of the following is a prime field ?
   (1) Q (2) R (3) $\mathbb{C}$ (4) Z_n
6. Let G be a commutative group having composition series. Then G must be :
   (1) Infinite (2) Finite
   (3) Finite with $G' = G$ (4) Infinite with $Z(G) = < e >$
7. Let M be a simple R-module and $T \in \text{Home}_R(M, M)$ such that $T \neq 0$, then :
   (1) $I_m(T) = O$ (2) $\ker(T) = M$ (3) T is singular (4) T is non-singular
8. A composition series for a group is :
   (1) Central series (2) Derived series (3) Solvable series (4) None of these
9. The degree of the splitting field of the polynomial $f(x) = x^{10} - 1$ over Q is :
   (1) 10 (2) 4 (3) 6 (4) 8
10. Any group of order 15 is :
    (1) Abelian (2) Simple (3) Cyclic (4) p-group
11. If a function $f(z)$ is analytic except at finite number of singularities (including that at infinity), then the sum of residues of these singularities is :
    (1) $2\pi i$ (2) πi (3) finite (4) zero

12. The transformation $f(z) = x - iy$ is :
(1) analytic (2) conformal (3) isogonal (4) none of these

13. The set of all bilinear transformation under the product of transformations form a :
(1) Monoid (2) Abelion group (3) Semi group (4) Non-Abelion group

14. The function $f(z) = e^{1/z}$ has essential singularity at :
(1) $Z = 1$ (2) $Z = 0$ (3) $Z = 2$ (4) $Z = -1$

15. Which of the following statement is ***not true*** ?
(1) Exponential function is analytic
(2) Absolute value function when defined on the set of real or complex numbers is analytic
(3) Power functions are analytic
(4) Any polynomial is an analytic function

16. The simple poles of Gamma function are at :
(1) $Z = 0, 1, 2, \ldots, n, \ldots$ (2) $Z = 0, -1, -2, \ldots, -n, \ldots$
(3) $Z = 1, 2, \ldots, n, \ldots$ (4) None of these

17. If $f(z)$ and $g(z)$ are analytic inside and on a closed contonic and $|g(z)| < |f(z)|$ on C, then $f(z)$ and $f(z) + g(z)$ have same :
(1) value (2) number of poles
(3) number of singularities (4) number of zeros

18. The residue of $f(z) = \dfrac{z^3}{z^2 - 1}$ at $z = \infty$ is :
(1) -1 (2) 1 (3) 0 (4) 3

19. The Taylor series of the function $\log(1 + Z)$ about the point $Z = 0$ is convergent for the region :
(1) $|Z| \le 1$ (2) $|Z| < 1$ (3) $|Z| \ge 1$ (4) $|Z| > 1$

20. Which of the following statement is ***not correct*** ?
(1) v is a harmonic conjugate of u if and only if u is a harmonic conjugate of $-v$.
(2) An analytic function with constant modulus is constant.
(3) If v is a harmonic conjugate of u in the same domain, then u is a harmonic conjugate of v.
(4) Both the real and imaginary parts of an analytic function are harmonic.

21. The result "Let $< f_n >$ be a sequence of non-negative measurable functions which converge almost everywhere on a set E to a function f. Then $\int_E f \leq \underline{\lim} \int_E f_n$ " is known as :

(1) F. Riesz Theorem

(2) Bounded Convergence Theorem

(3) Fatou's Lemma

(4) Lebesgue Monotone Convergence Theorem

22. The members of the smallest σ-algebra which contains all of the open sets are called :

(1) Lebesgue sets (2) Borel sets

(3) σ-open sets (4) Lebesgue measurable sets

23. For $o \leq p \leq 1$, the series $\sum_{n=1}^{\infty} \frac{(-1)^n}{n^p}$ is :

(1) convergent but not absolutely (2) convergent

(3) absolutely convergent (4) oscillatory

24. The series $\sum_{n=1}^{\infty} \frac{\cos n\theta}{n^p}$ converges uniformly for all values of θ if :

(1) $p \geq 1$ (2) $p < 1$ (3) $p \leq 1$ (4) $p > 1$

25. Outermeasure is a set function whose domain is :

(1) P(R) (2) R

(3) Collection of all measurable sets (4) Collection of all continuous functions

26. Which of the following is ***not true*** ?

(1) Every absolutely continuous function is of bounded variation

(2) Every bounded function is of bounded variation

(3) Every monotone function on $[a, b]$ is of bounded variation

(4) Every function of bounded variation is bounded

27. The word 'Topologi' was introduced in Germany in 1847 by :

(1) George Cantor (2) Johann Benedict

(3) Kazimierz Kuratowski (4) Felix Hausdorff

28. A function which is analytic for all finite values of Z and bounded is :

(1) a constant (2) zero (3) a function of Z (4) continuous

29. The result "The order of a canonical product is equal to the exponent of convergence of its zeros" is known as :

(1) Borel's theorem (2) Jensen's formula

(3) Bloch's theorem (4) Morera's theorem

30. The constant

$$r = \lim_{n\to\infty}\left(1+\frac{1}{2}+\frac{1}{3}+\cdots+\frac{1}{n}-\log n\right)$$

is called :

(1) Euler's constant (2) Euler's number

(3) Lebesgue constant (4) Lebesgue number

31. The function $D:R\to R$ such that

$$D(x)=\begin{cases}1 \text{ if } & x\in Q\\ 0 \text{ if } & x\notin Q\end{cases}$$

is known as :

(1) Step Function (2) Simple Function

(3) Characteristic Function (4) Dirichlet's Function

32. Every convergent sequence of measurable functions is nearly uniformly convergent. This result is known as :

(1) 1st principle of measurability (2) Littlewood's 2nd principle of measurability

(3) Littlewood's third principle (4) Egorov's theorem

33. If a_n and b_n are sequences of extended real numbers and $a_n \le b_n$ for all n sufficiently large. Which of the following is ***not true*** ?

(1) $\lim\inf a_n \ge \lim\inf b_n$ (2) $\lim\inf a_n \le \lim\inf b_n$

(3) $\lim\sup a_n \le \lim\sup b_n$ (4) None of these

34. The composition of two Lebesgue measurable functions is :

(1) not necessarily Lebesgue measurable

(2) Borel measurable

(3) always measurable

(4) always Lebesgue measurable

35. Every uniformly continuous function is :

(1) Absolutely continuous (2) Not absolutely continuous

(3) Not Continuous (4) None of these

36. Which of the following statements is ***not correct*** ?

(1) Ch. function of irrational numbers in [0, 1] is Riemann integrable

(2) Ch. functions are simple functions

(3) Ch. function of the set E of rational numbers in [0, 1] is measurable

(4) None of the above

37. Let A be the set of algebraic numbers. Then the outer measure of A is equal to :

(1) ∞ (2) a finite measure

(3) zero (4) outer measure of the set of real numbers

38. The axiom of choice was formulated in 1904 by :

(1) Riemann (2) Ernst Zermelo (3) G. H. Moore (4) George Cantor

39. The result "Let $(-1, 1)$ be interval of convergence for the power series $\sum a_n x^n$. If $\sum_{n=0}^{\infty} a_n = S$, then $\lim_{x \to 1-0} \sum_{n=0}^{\infty} a_n x^n = S$" is known as :

(1) Uniqueness theorem (2) Weierstrass's theorem

(3) Tauber's theorem (4) Abel's theorem

40. If a function f is convex and $f(0) \le 0$, then :

(1) f is superadditive on the positive half axis

(2) f is additive

(3) f is subadditive on the positive half axis

(4) f is superconvex

41. A condition is said to be steady-state if the dependent variables are :

(1) Not present in Heat equation (2) Independent of time t

(3) Dependent on time t (4) None of these

42. The one-dimensional wave equation for an elastic string of length L under boundary conditions $y(0, t) = 0$, $y(L, t) = 0$ indicates that :

(1) the string is not fixed at $x = 0$ (2) the string is only fixed at $x = 0$

(3) the string is fastened at both ends (4) none of these

43. If H represents Hamiltonian function, then $\frac{dH}{dt}$ is equal to :

(1) $\frac{\partial H}{\partial t}$ (2) $\frac{\partial^2 H}{\partial t^2}$ (3) $\frac{d^2 H}{dt^2}$ (4) None of these

44. The two dimensional Laplace equation in polar co-ordinates is given by :

(1) $\frac{\partial^2 u}{\partial r^2}+\frac{1}{r}\frac{\partial u}{\partial r}=0$

(2) $\frac{\partial^2 u}{\partial r^2}+\frac{\partial u}{\partial r}+\frac{1}{r}\frac{\partial^2 u}{\partial \theta^2}=0$

(3) $\frac{\partial u}{\partial r}+\frac{1}{r}\frac{\partial^2 u}{\partial \theta^2}+\frac{1}{r^2}\frac{\partial^2 u}{\partial r^2}=0$

(4) $\frac{\partial^2 u}{\partial r^2}+\frac{1}{r}\frac{\partial u}{\partial r}+\frac{1}{r^2}\frac{\partial^2 u}{\partial \theta^2}=0$

45. For the heat conduction equation $\frac{\partial u}{\partial t}=c\frac{\partial^2 u}{\partial x^2}$ in a bar subject to the boundary conditions that the end $x = 0$ is held at zero temperature and the end $x = 1$ is at temperature zero, the boundary conditions can be expressed at :

(1) $u(0, t) \neq 0; u(1, t) = 0$

(2) $u(1, t) \neq 0; u(0, t) = 0$

(3) $u(0, t) = 0; u(1, t) = 0$

(4) $u(0, t) \neq 0; u(1, t) \neq 0$

46. The boundary value problem which models the displacement function for a semi-infinite string which is initially undisturbed and is given an initial velocity is expressed as :

(1) $\frac{1}{c^2}\frac{\partial^2 u}{\partial t^2}=\frac{\partial^2 u}{\partial x^2}$; $u(x, 0) \neq 0$

(2) $\frac{1}{c^2}\frac{\partial^2 u}{\partial t^2}=\frac{\partial^2 u}{\partial x^2}$; $u(0, t)=0$; $u(x, 0)=0$

(3) $\frac{1}{c^2}\frac{\partial^2 u}{\partial t^2}=\frac{\partial^2 u}{\partial x^2}$; $u(x, 0)=0$; $\frac{\partial u}{\partial t}(x, 0)=0$

(4) $\frac{1}{c^2}\frac{\partial^2 u}{\partial t^2}=\frac{\partial^2 u}{\partial x^2}$; $u(x, 0)=0$; $\frac{\partial u}{\partial t}(x, 0)=f(x)$

47. For the Lagrangian function $L(t, q_i, q_i)$ the generalized momenta p_i is defined as :

(1) $p_i=\frac{\partial L}{\partial q_i}$ (2) $p_i=\frac{\partial L}{\partial \dot{q}_i}$ (3) $p_i=\frac{\partial^2 L}{\partial q_i^2}$ (4) None of these

48. If a lead is sliding on a uniformly rotating wire in a force free space, then the equations of motion are :

(1) $\ddot{r}=rw^2$ (2) $\dot{r}=rw^2$ (3) $\ddot{r}=rw$ (4) $r=\ddot{r}w^2$

49. Principle of least action states that the variation of the Lagrange action W^* is zero for :

(1) the parabolic path (2) the circular path

(3) any path (4) the straight line path

50. Which one of the following form a set of Routh's equations ?

(1) $\frac{dq_\alpha}{dt} = \frac{\partial R}{\partial p_\alpha}, \frac{dp_\alpha}{dt} = -\frac{\partial R}{\partial q_\alpha}$ (2) $\frac{dq_\alpha}{dt} = -\frac{\partial R}{\partial p_\alpha}, \frac{dp_\alpha}{dt} = -\frac{\partial R}{\partial q_\alpha}$

(3) $\frac{dq_\alpha}{dt} = -\frac{\partial R}{\partial p_\alpha}, \frac{dp_\alpha}{dt} = \frac{\partial R}{\partial q_\alpha}$ (4) $\frac{dq_\alpha}{dt} = \frac{\partial R}{\partial p_\alpha} = -\frac{\partial R}{\partial q_\alpha}$

51. Solution of the I. V. P.

$$\frac{dy}{dx} = -y,\ y(0) = 1 \text{ is :}$$

(1) e^t (2) e^{-t} (3) $e^{-t/2}$ (4) $e^{t/2}$

52. Solution of the integral equation $\int_0^x e^{x-t} u(t)dt = x$ is :

(1) $x-1$ (2) x^2-1 (3) $1-x$ (4) x

53. The eigen values of the integral equation

$$u(x) = \lambda \int_{-1}^{1} (x+t)u(t)dt \text{ are :}$$

(1) $\pm\frac{\sqrt{3}}{2}$ (2) $\pm i\frac{\sqrt{3}}{2}$ (3) $\pm i\sqrt{3}$ (4) $1 \pm i\sqrt{3}$

54. If the homogeneous Fredholm integral equation :

$$u(x) = \lambda \int_a^b k(x,t)\, u(t)\, dt$$

has only a trivial solution, then the corresponding non-homogeneous equation has always :

(1) no solution (2) Infinite number of solutions

(3) a unique solution (4) only trivial solution

55. Which of the following theorem expresses the symmetric Kernel of a Fredholm integral equation as an infinite series of product of its orthogonal eigen functions ?

(1) Poincare Bendixon Theorem (2) Bendixon Theorem

(3) Hilbert-Schmidt Theorem (4) Mercer's Theorem

56. The problem of Brachistochrone (shortest time) was first formulated in the year 1696 by :

(1) Newton (2) Jeans Bernouli (3) Leibnitz (4) Jacques Bernouli

57. The curve which minimizes the functional $J(y) = \int_a^b (x-y)^2\, dx$ is :

(1) $x - y = 0$ (2) $x + y = 0$ (3) $x - 2y = 0$ (4) $y - 2x = 0$

58. The geodesics of the circular cylinder $\vec{r} = (a\cos\phi, a\sin\phi, z)$ is :

(1) Circle (2) Catenary (3) Straight line (4) Helix

59. In the Lipschitz condition $|f(t,y_1) - f(t,y_2)| \le k|y_1 - y_2|$ condition on k is :

(1) $k > 0$ (2) $k \ge 0$ (3) $0 < k \le 1$ (4) $k < 1$

60. If a rigid body rotates about a fixed point with an angular velocity $\vec{\omega}$ and has an angular momentum $\vec{H}$, then the kinetic energy T is given by :

(1) $\vec{\omega} \times \vec{H}$ (2) $\dfrac{\Delta.\vec{\omega}}{\vec{H}}$ (3) $\dfrac{1}{2}\vec{\omega}.\vec{H}$ (4) none of these

61. "A function $f(z)$ whose only singularities in the entire complex plane are poles" is called a :

(1) Analytic Function (2) Harmonic Function

(3) Entire Function (4) Meromorphic Function

62. Which of the following statement is ***not correct*** ?

(1) Subspace of Hausdorff space is Hausdorff

(2) Product of two Hausdorff spaces is Hausdorff

(3) The space X is Hausdorff if and only if the diagonal $\Delta = \{x \times x\,; x \in X\}$ is open in XXX

(4) The space X is Hausdorff if and only if the diagonal $\Delta = \{x \times x\,; x \in X\}$ is closed in XXX

63. The result "Let $X = A \cup B$ where A and B are closed in X. Let $f : A \to Y$ and $g : B \to Y$ be continuous. If $f(x) = g(x)$ for every $x \in A \cap B$, then f and g combine to give a continuous function $h : X \to Y$ defined by setting $h(x) = f(x)$ if $x \in A$ and $h(x) = g(x)$ if $x \in B$" is called :

(1) Pasting Lemma (2) Zorn's Lemma

(3) Embedding Lemma (4) Sequence Lemma

64. Every metric space is :

(1) Normed space (2) Paracompact

(3) Compact (4) Not first axiom sapce

65. If J is the Jacobian of functions u and v w.r.t. x and y and J_0 is the Jacobian of x and y. w.r.t. u and v, then :

(1) $JJ_0 = 1$ (2) $JJ_0 = 0$ (3) $JJ_0 = -1$ (4) $JJ_0 = 2$

66. Any infinite cyclic group has exactly k generators where :

(1) $k = 1$ (2) $k = 3$ (3) $k = 2$ (4) $k = 7$

67. The index of a saddle point is :

(1) 0 (2) 1 (3) -1 (4) does not exist

68. Let $F = \{f\}$ be an equicontinuous family of functions defined on a real interval I, then each function f is :

(1) continuous on I (2) uniformly continuous on I

(3) not continuous on I (4) constant on I

69. The critical point (0, 0) of the system $\frac{dx}{dt} = 4y, \frac{dy}{dt} = x$ is :

(1) stable (2) asymptotically stable

(3) not stable (4) stable but not asymptotically stable

70. Consider the linear autonomous system

$$\frac{dx}{dt} = ax + by, \frac{dy}{dt} = cx + dy$$

where a, b, c, d are real constants. If $a = d$ and b and c are of same sign such that $\sqrt{bc} < |a|$, then the critical point (0, 0) of the system is :

(1) saddle point (2) spiral point (3) node (4) centre

71. The concept of reflexivity was introduced by :

(1) H. Hahn (2) F. Riesz (3) R. C. James (4) D. Hilbert

72. Which of the following is ***not*** a Hilbert space ?

(1) R^n (2) l_2 (3) $L_2[0, 1]$ (4) $L_1[0, 1]$

73. In a normed linear space, weak convergence implies strong convergence if :

(1) $\dim X < \infty$ (2) $\dim X > \infty$ (3) $\dim X = \infty$ (4) none of these

74. Which of the following is ***not true*** ?

(1) C as a real vector space is of dimension two

(2) $\mathbb{C}$ as a complex vector space is of dimension one

(3) l_1 is reflexive

(4) Space $C[a, b]$ is dense in $L_p[a, b]$

75. If x and y are orthonormal vectors in a Hilbert space H, then :

(1) $\|x-y\|=2$ (2) $\|x-y\|=\sqrt{2}$ (3) $\|x-y\|=0$ (4) $\|x-y\|=1$

76. L^p-spaces are complete. This result is known as :

(1) F. Riesz Theorem (2) Riesz Fisher Theorem

(3) Lebesgue Theorem (4) Jordan Decomposition Theorem

77. If P is a projection on a closed linear subspace M of H, then M is invariant under :

(1) $TP = PT$ (2) $P = TPT$ (3) $T = PTP$ (4) $TP = PTP$

78. If P is a projection on a Hilbert space H, then which of the following is ***not true*** ?

(1) P is a positive operator (2) $O \leq P \leq 1$

(3) $\|P\|>1$ (4) $\|Px\| \leq \|x\| \quad \forall x \in H$

79. A one to one continuous linear transformation of a Banach space onto another Banach space is a :

(1) Homomorphism (2) Homeomorphism

(3) Closed Mapping (4) Open Mapping

80. A subspace Y of a Banach space Y is complete if and only if :

(1) The set Y is open in X (2) The set Y is complete in X

(3) The set Y is closed in X (4) None of the above

81. Which one of the following is ***not*** a topological property ?

(1) Boundedness (2) Compact (3) Closed (4) Open

82. Every metric space is paracompact. This theorem is named after :

(1) Stone (2) Michael (3) Lindelof (4) Hausdorff

83. Every convergent sequence in a topological space has a unique limit if X is :

(1) First countable Hausdorff space (2) T_1-space

(3) Hausdorff space (4) Second countable space

84. Regular spaces were first studied in 1921 by :

(1) Victoris (2) Hausdorff (3) Kolmogorov (4) Tietz

85. The result "A topological space is a Tychonoff space if and only if it is embeddable into a cube" is known as :

(1) Embedding Lemma (2) Tychonoff Embedding Theorem

(3) Urysohn's Metrization Theorem (4) None of these

86. The space $C[0, 1]$ is ***not*** a :

(1) Complete space (2) Normed linear space

(3) Metric space (4) Regular space

87. If (X, T) is an indiscrete topological space, then it has :

(1) no component (2) compact component

(3) finite number of components (4) only X as the component

88. For an empty set ϕ, which statement is ***true*** ?

(1) $d(\phi) = +\infty$ (2) $d(\phi) = -\infty$ (3) $\inf(\phi) = -\infty$ (4) none of these

89. Which of the following statement is ***not true*** ?

(1) R^n is connected (2) R is connected

(3) Q is connected (4) C^n is connected

90. The norm $||.||$ from a vector space X to R is a :

(1) Linear functional (2) Sublinear functional

(3) Bi-linear functional (4) Superlinear functional

91. The basis and the degree of the extension $Q(\sqrt{2}, \sqrt{3})$ over Q is :

(1) $\{\sqrt{2}, \sqrt{3}\}$, 4 (2) $\{1, \sqrt{2}, \sqrt{3}\}$, 4

(3) $\{1, \sqrt{2}, \sqrt{3}, \sqrt{6}\}$, 4 (4) $\{1, \sqrt{2}, \sqrt{3}\}$, 2

92. The set R of real numbers is :
(1) totally bounded (2) locally compact
(3) countably compact (4) sequentially compact

93. Every Lindelof metric space is :
(1) Compact (2) First countable
(3) Second countable (4) Reducible

94. Which of the following topology is coarser than the usual topology of R ?
(1) lower limit topology on R (2) upper limit topology on R
(3) co-countable topology on R (4) finite complement topology on R

95. Which of the following properties is Hereditary ?
(1) 2nd axiom of countablility (2) Compactness
(3) Lindelofness (4) Seperability

96. The concept of normality of a topological space was introduced by :
(1) Urysohn (2) Tichonov (3) Hausdorff (4) Tietze

97. Which of the following properties is ***not*** invariant under continuous map ?
(1) Lindeloffness (2) Separability
(3) 1st axiom of countability (4) Compactness

98. Which of the following statements is ***not correct*** ?
(1) Cantor set is perfect (2) Contor set is totally disconnected
(3) Cantor set is closed (4) Cantor set is countable

99. Let N be the set of non-negative integers. Then the collection

$H = \{F \; ; \; N - F \text{ is finite}\}$ is known as :

(1) Atomic Filter (2) Cofinite Filter
(3) Frechet Filter (4) Nbd Filter

100. Which of the following statement is ***not true*** ?
(1) Usual topological space (R, V) is Hausdorff
(2) Every indiscrete space containing at least two points is metrizable
(3) Every Discrete topological space is Hausdorff
(4) All metric spaces are Hausdorff