Reg. No. : .....

Code No. : 7881 **Sub. Code : VMAC 31**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2025.

Third Semester

Mathematics

Core — ADVANCED ALGEBRA – I

(For those who joined in July 2024-2025 onwards)

Time : Three hours Maximum : 75 marks

PART A — ($15 \times 1 = 15$ marks)

Answer ALL questions.

Choose the correct answer :

1. If $\dim_F V = m$ then $\dim_F \mathrm{Hom}(V, V)$ = _____.

(a) m (b) m^2

(c) mn (d) 1

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2. If W is a subspace of V then the annihilator of W, $A(W) =$ _____.

(a) $\{f \in \hat{V} / f(w) = 0 \text{ all } w \in W\}$

(b) $\{f \in \hat{V} / f(w) \neq 0 \text{ for all } w \in W\}$

(c) $\{f \in V / f(v) \neq 0 \text{ for all } w \in V\}$

(d) $A(A(W)) = W$

3. An element $T \in A(V)$ is regular if there is an element $S \in A(V)$ such that _____.

(a) $ST^{-1} = T^{-1}$ (b) $ST = TS = 1$

(c) $S = T$ (d) Singular

4. If $C = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 \end{pmatrix}$ then $C^{-1} =$ _____.

(a) $\begin{pmatrix} 1 & 0 & 0 & 0 \\ -1 & 1 & 0 & 1 \\ -1 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 \end{pmatrix}$ (b) $\begin{pmatrix} 1 & 0 & 0 & 0 \\ -1 & 1 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ -1 & 0 & 0 & 1 \end{pmatrix}$

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

5. The Linear transformations $S, T \in A(V)$ are said to be similar if there exists an _____ element $C \in A(V)$ such that $T =$ _____.

(a) Invertible, $CAC = A$

(b) Invertible, $CSC^{-1} = T$

(c) Singular, $T = CSC^{-1}$

(d) Regular, $T \neq CSC^{-1}$

6. If F is the field of real numbers then the minimal equation of $\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$ over F is _____.

(a) $x^2 - 1$ (b) $x^2 + 1$

(c) $-x^2 + 1$ (d) $x^3 + 1$

7. The number of distinct similarity classes of nilpotent $n \times n$ matrices is _____.

(a) $p(n)$, the number of partitions of n

(b) The minimal polynomial

(c) $ATA^{-1} = n \times n$

(d) Invariants

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8. Two nilpotent linear transformations are similar if they have the _____.

(a) Different invarients

(b) Same invarients

(c) Nilpotent

(d) Unique dimension

9. If S and T are nipotent linear transformation then

(a) $S+T$ is a nilpotent linear transformation

(b) ST is a linear transformation

(c) Both (a) and (b)

(d) Neither (a) nor (b)

10. Every characteristic root of T is a root of _____.

(a) Minimal Polynomial

(b) $p_r(x)$

(c) $q_i(x)$

(d) Characteristic polynomial

11. If A is invertible then $tr(A \subset A^{-1}) =$ _____.

(a) $tr\,C$ (b) $tr\,A$

(c) $tr\,A\,A^{-1}$ (d) $tr\,CA^{-1}$

12. If F is a field of characteristic 2 then the unit matrix $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ in F_2 has trace _____.

(a) 1 (b) 2

(c) 0 (d) –1

13. If $S, T \in A(V)$ then $(ST)^* =$ _____.

(a) T^*S^* (b) S^*T^*

(c) TT^* (d) $S^* + T^*$

14. $T \in A(V)$ is called Hermitian if _____.

(a) $TT^* = 1$ (b) $T^* = T$

(c) $T^* = -T$ (d) $TT^* = T^*T$

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15. If T is unitary then T is _____.

(a) Singular (b) Regular

(c) Non Singular (d) Orthogonal

PART B — ($5 \times 4 = 20$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Prove that $A(W)$ is a subspace of $\hat{V}$.

Or

(b) Show that if V is finite dimensional over F then $T \in A(V)$ is regular if and only if T maps V onto V.

17. (a) If $\lambda \in F$ is a characteristic root of $T \in A(V)$ then prove that for any polynomial $q(x) \in F[x], q(\lambda)$ is a characteristic root of $q(T)$.

Or

(b) Prove that given the matrix

$$A = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 6 & -11 & 6 \end{pmatrix} \in F_3 \text{ then}$$

$A^3 - 6A^2 + 11A - 6 = 0$.

18. (a) Define the following :

(i) Index of nilpotence.

(ii) Cyclic with respect to T, $T \in A(V)$.

Or

(b) Show that if $V = V_1 \oplus \ldots \oplus V_k$ where each V_i is invarient under T and if $P_i(x)$ is the minimal polynomial over F of T_i, the linear transformation induced by T on V_i then the minimal polynomial of T over F is the least common multiple of $p_1(x), p_2(x) \ldots, p_k(x)$.

19. (a) For $A, B \in F_n$ for $\lambda \in F$; prove the following :

(i) $tr(\lambda a) = \lambda tr A$

(ii) $tr(A + B) = tr A + tr B$

(iii) $tr(AB) = tr(BA)$.

Or

(b) Show that the determinant of a triangular matrix is the product of its entries on the main diagonal.

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20. (a) Show that if $T \in A(V)$ is Hermitian then all its characteristic roots are real.

Or

(b) Show that the Hermitian linear transformation T is non negative if and only if all of its characteristic roots are non negative.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

21. (a) Show that if V is finite dimensional and $v \neq 0 \in V$ then there is an element $f \in \hat{V}$ such that $f(v) \neq 0$.

Or

(b) Show that if A is an algebra with unit element over F, then A is isomorphic to a subalgebra of $A(V)$ for some vector space V over F.

22. (a) Show that if V is n-dimensional over F and if $T \in A(V)$ has the matrix $m_1(T)$ in the basis $v_1, v_2, \ldots, v_n$ and the matrix $m_2(T)$ in the basis $w_1, w_2, \ldots, w_n$ of V over F then there is an element $C \in F_n$ such that $m_2(T) = Cm_1(T)C^{-1}$.

Or

(b) Show that if $T \in A(V)$ has all its characteristic roots in F then there is a basis of V in which the matrix of T is triangular.

23. (a) Show that if M, of dimension m, is cyclic with respect to T, then the dimension of MT^K is $m - k$ for all $k \leq m$.

Or

(b) For each $i = 1, 2, \ldots k$, $v_i \neq (0)$ and $V = V_1 \oplus V_2 \oplus \ldots \oplus V_k$. Prove that the minimal polynomial of T_i is $q_i(x)^{l_i}$.

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24. (a) Show that $\det A = \det (A')$.

Or

(b) Let V and W be two vector spaces over F and suppose that ψ is a vector space isomorphism of V onto W. Suppose that $S \in A_F(V)$ and $T \in A_F(W)$ are such that for any $v \in V$, $(vs)\psi = (v\psi)T$. Then prove that S and T have the same elementary divisors.

25. (a) (i) If N is normal and if $vN^k = 0$ then prove that $vN = 0$.

(ii) If N is normal and $AN = NA$ then prove that $AN^* = N^*A$.

Or

(b) (i) Show that $T \geq 0$ iff $T = AA^*$ for some A.

(ii) Show that congruence is an equivalence relation.

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(8 pages) **Reg. No. :** .....

Code No. : 7882 **Sub. Code : VMAC 32**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2025.

Third Semester

Mathematics – Core

COMPLEX ANALYSIS

(For those who joined in July 2024-2025 onwards)

Time : Three hours Maximum : 75 marks

PART A — (15 × 1 = 15 marks)

Answer ALL questions.

Choose the correct answer :

1. If $u + iv = e^{-z}$ then u_x is

(a) $-e^x \cos y$ (b) $e^x \cos y$

(c) $e^{-x} \sin y$ (d) $-e^{-x} \sin y$

2. If $S(z) = \frac{\alpha z + \beta}{\gamma z + \delta}$ with $\alpha\delta - \beta\gamma \neq 0$, then $S^{-1}(w)$ is given by

(a) $\frac{\delta w + \beta}{\gamma w + \alpha}$ (b) $\frac{\delta w - \beta}{\gamma w - \alpha}$

(c) $\frac{\delta w - \beta}{-\gamma w + \alpha}$ (d) $\frac{\delta w + \beta}{-\gamma w + \alpha}$

3. The radius of convergence of the power series $\sum \frac{1}{n^n} z^n$ is

(a) 0 (b) 1

(c) n (d) ∞

4. The value of $\int_{|z|=1} \frac{e^z}{z} dz$ is

(a) 0 (b) 2π

(c) $2\pi i$ (d) $2\pi e$

5. Every polynomial of degree ≥ 1 has at least one zero in $\mathbb{C}$ is the statement of

(a) Liouville's theorem

(b) Morera's theorem

(c) Fundamental theorem of algebra

(d) Cauchy's theorem

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6. If $f(z)$ and $g(z)$ have the algebraic orders h and k at $z = a$, then fg has the order.

(a) $h + k$ (b) hk

(c) $\max\{h, k\}$ (d) $\min\{h, k\}$

7. A chain is a cycle if it can be represented as a sum of

(a) continuous curves (b) arcs

(c) closed curves (d) differentiable curves

8. The residue of $\dfrac{e^z}{(z-a)(z-e)}$ at b (where $a \neq b$) is

(a) $\dfrac{e^a}{a-b}$ (b) $\dfrac{e^b}{a-b}$

(c) $\dfrac{e^b}{b-a}$ (d) $\dfrac{e^a}{b-a}$

9. A cycle γ is an open set Ω is said to be homologous to zero w.r.t Ω it $n(\gamma, a) = 0$ for all point a

(a) in Ω

(b) in the complement of Ω

(c) in γ

(d) in the complement of γ

10. The arithmetic mean of a harmonic function oven concentric circles $|z| = r$ is a

(a) constant

(b) linear function of r

(c) linear function of $\log r$

(d) linear function of z

11. Let A be the set of all points a with $n(\gamma, a) = 0$. Which one of the following is not true?

(a) A is open

(b) A contains all points outside of a large circle

(c) A is compact

(d) $A = \mathbb{C}$

12. The value of $\int_0^\infty \dfrac{\sin x}{x} dx$ is

(a) $\pi/2$ (b) $\dfrac{\pi i}{2}$

(c) $2\pi i$ (d) $\dfrac{1}{2\pi i}$

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13. The Poisson integral of U is

(a) $\frac{1}{2\pi}\int_0^{2\pi} \mathrm{Re}\frac{e^{i\theta}+z}{e^{i\theta}-z}U(\theta)d\theta$

(b) $\frac{1}{2\pi i}\int_0^{2\pi} \mathrm{Re}\frac{e^{i\theta}+z}{e^{i\theta}-z}U(\theta)d\theta$

(c) $\frac{1}{2\pi}\int_0^{2\pi} \mathrm{Re}\frac{e^{i\theta}+z}{e^{i\theta}-z}d\theta$

(d) $\frac{1}{2\pi}\int_0^{2\pi} \mathrm{Re}\frac{e^{i\theta}-z}{e^{i\theta}+z}U(\theta)d\theta$

14. $z-\frac{z^3}{3!}+\frac{z^5}{5!}-\frac{z^7}{7!}+\ldots$ is

(a) $\cos z$ (b) $\sin z$

(c) e^z (d) e^{-z}

15. if the functions $f_n(z)$ are analytic and $\neq 0$ in a region Ω, and if $f_n(z)$ converges to $f(z)$ uniformly on every compact subset of Ω, then

(a) $f(z) \equiv 0$

(b) $f(z)$ never equal to zero in Ω

(c) $f(z)$ is a constant

(d) $f(z)$ is either identically zero or never equal to zero in Ω

PART B — ($5 \times 4 = 20$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) If $g(w)$ and $f(z)$ are analytic functions, show that $g(f(z))$ is also analytic.

Or

(b) Prove that every rational function has a representation by partial fractions.

17. (a) State and prove Liouville's theorem.

Or

(b) State and prove Weierstrass theorem on essential signularity.

18. (a) State and prove the residue theorem.

Or

(b) State and prove the argument principle.

19. (a) If u_1 and u_2 are harmonic functions in Ω, prove that $\int_\gamma u_1 \times du_2 - u_2 \times du_1 = 0$ for every cycle γ which is homologous to zero in Ω.

Or

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(b) Suppose that $u(z)$ is harmonic for $|z| > R$, continuous for $|z| \leq R$. Prove that

$$u(a) = \frac{1}{2\pi} \int_{|z|=R} \frac{R^2 - |a|^2}{|z-a|^2} u(z) d\theta \text{ for all } |a| < R.$$

20. (a) Explain the geometric interpretation of Poisson's formula due to Schwarz.

Or

(b) State and prove Hurwitz theorem.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

21. (a) State and prove Lucas's theorem.

Or

(b) State and prove Abel's theorem for power series.

22. (a) Suppose that $\phi(\xi)$ is continuous on the arc γ. Prove that the function $Fn(z) = \int_{\gamma} \frac{\phi(\xi) d\xi}{(\xi - z)^n}$ is analytic in each of the regions determined for γ and its derivative is $Fn'(z) = nF_{n+1}(z)$.

Or

(b) State and prove Taylor's theorem.

23. (a) Prove that a region Ω is simply connected if and only if $n(\gamma, a) = 0$ for all cycles γ in Ω and all points a which do not belong to Ω.

Or

(b) State and prove Rouche's theorem.

24. (a) Evaluate $\int_{-\infty}^{+\infty} \frac{x^2 - x + 2}{x^4 + 10x^2 + a} dx$.

Or

(b) State and prove that mean value property of a harmonic function.

25. (a) Prove that the function $P_U(z)$ is harmonic for $|z| < 1$ and $\lim_{z \to e^{i\theta_0}} P_U(z) = U(\theta_0)$ provided that U is continuous at θ_0.

Or

(b) State and prove Weierstrass's theorem.

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(8 pages) **Reg. No. :** .....

Code No. : 7408 **Sub. Code : WMAM 33/ VMAC 33**

M.Sc. (CBCS) DEGREE EXAMINATION, NOVEMBER 2025.

Third Semester

Mathematics – Core

TOPOLOGY

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — (15 × 1 = 15 marks)

Answer ALL questions.

Choose the correct answer :

1. Which one of the following is not a topology on $X = \{a,b,c\}$?

(a) $\{\phi, x\}$ (b) $\{\phi, \{a\}, x\}$

(c) $\{\phi, \{a,b\}, \{b,c\}, x\}$ (d) $\{\phi, \{b\}, x\}$

2. Let π_1 be the projection of $X \times Y$ onto X. If U is open in X then $\pi_1^{-1}(U)$ is

(a) U (b) $U \times Y$

(c) $X \times U$ (d) $U \times U$

3. A subset of a topological space is closed iff it contains all its _____.

(a) open (b) closed

(c) limit points (d) subspace

4. Let $f : X \to Y$ is continuous and A is a subset of X then

(a) $f(\overline{A}) = \overline{f(A)}$ (b) $\overline{f(A)} \subset f(\overline{A})$

(c) $f(\overline{A}) \subseteq \overline{f(A)}$ (d) $\overline{f(A)} \subseteq f(A)$

5. If d is the Euclidean metric and ρ is the square metric on $\mathbb{R}^n$ then

(a) $\rho(x,y) \le d(x,y) \le \sqrt{2}\rho(x,y)$

(b) $d(x,y) \le \rho(x,y) \le \sqrt{n}d(x,y)$

(c) $\rho(x,y) \le d(x,y) \le \sqrt{n}\rho(x,y)$

(d) $\sqrt{n}\rho(x,y) \le d(x,y) \le \rho(x,y)$

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6. If A is a subspace of X, the inclusion function $j: A \to Y$ is continuous is _____.

(a) composition (b) constant

(c) inclusion (d) continuous

7. Which one of the following is corrected?

(a) $[-1,0) \cup (0,1]$ (b) Q

(c) $\mathbb{R}_l$ (d) $[-1, 1]$

8. The image of a connected space under a continuous map in _____.

(a) connected (b) continuous

(c) compact (d) none

9. A finite Cartesian product of connected space is _____.

(a) connected (b) continuous

(c) closed (d) compact

10. The image of a compact space under a continuous map is _____.

(a) connected (b) continuous

(c) compact (d) none

11. Every closed subspace of a compact space is _____.

(a) connected (b) closed

(c) compact (d) none

12. Which one of the following is compact in $\mathbb{R}$.

(a) [0, 1] (b) [0, 1)

(c) (0, 1) (d) (0, 1]

13. Regular space is also known as

(a) T_4 (b) T_3

(c) T_2 (d) T_1

14. A space for which every open covering contains a countable subcovering is called

(a) Separable (b) Lindelof

(c) Countable (d) Connected

15. Normal space is also known as

(a) T_4 (b) T_3

(c) T_2 (d) T_1

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PART B — (5 × 4 = 20 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Let $\mathcal{B}$ is a basis for the topology of X. Prove that the collection $B_Y = \{B \cap Y : B \in \mathcal{B}\}$ is a basis for subspace topology on Y.

Or

(b) Let Y be a subspace of X. Let $A \subseteq Y$. Let $\overline{A}$ denote the closure of A in X. Prove that the closure of A in Y equals $\overline{A} \cap Y$.

17. (a) State and prove :

(i) inclusion function

(ii) composition function.

Or

(b) State and prove sequence lemma.

18. (a) Let A be a connected subspace of X. If $A \subset B \subset \overline{A}$. Prove that B is also connected.

Or

(b) Prove that the union of collection of connected subspace of X that have a point in common is connected.

19. (a) Prove that continuous compact space is compact.

Or

(b) Prove that compactness implies limit point compactness but not conversely.

20. (a) Prove that the subspace of a Hausdorff space is Hausdorff.

Or

(b) Prove that every metrizable space is normal.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

21. (a) Define the standard topology, Re-topology, $\mathbb{R}_k$ – topology on $\mathbb{R}$. Find the relation between these topologies.

Or

(b) If $\mathcal{G}$ is a collection of open sets in a topologies space X such that for each open set U of X and each x in U there is an element C of $\mathcal{G}$ such that $x \in C \subseteq U$, prove that $\mathcal{G}$ is a basis for the topology of X.

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22. (a) Let $f : X \to Y$, let X and Y be metrizable with metrics d_x and d_y respectively. Prove that continuity of f is equivalent to the requirement $d_x(x,y) < \delta \Rightarrow d_y(f(x),f(y)) < \varepsilon$.

Or

(b) Prove that the topologies of $\mathbb{R}^n$ induced by Euclidean metric d and the square metric ρ are the same as the product topology on $\mathbb{R}^n$.

23. (a) Prove that X is connected space $\Leftrightarrow$ the only subsets of X, that are both open and closed in X are the empty set and X itself.

Or

(b) Prove that a finite Cartesian product of connected space is connected.

24. (a) Let X be a metrizable space prove that the following are equivalent.

(i) X is compact

(ii) X is limit point compact

(iii) X is sequentially compact.

Or

(b) Let X be a space. If X is locally compact Haudorff. Prove that there exists a space Y satisfying.

(i) X is a subspace of Y.

(ii) $Y - X$ consists of a single point.

(iii) Y is compact Haudorff space.

25. (a) State and prove the Urysohn lemma.

Or

(b) Prove that :

(i) A subspace of a completely regular space is completely regular.

(ii) A product of completely regular space are completely regular.

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(7 pages) **Reg. No. :** .....

Code No.: 7409 **Sub. Code: WMAM 34/ VMAC 34**

M.Sc. (CBCS) DEGREE EXAMINATION, NOVEMBER 2025.

Third Semester

Mathematics – Core

(Industry Module) : CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — (15 × 1 = 15 marks)
Answer ALL questions.
Choose the correct answer :

1. A necessary condition for the existence of a maximum or minimum at a point x_0, inside (a,b) is that _____.

(a) $\frac{dy}{dx} < 0$ at x_0 (b) $\frac{dy}{dx} > 0$ at x_0

(c) $\frac{dy}{dx} = 0$ at x_0 (d) $\frac{dy}{dx} \neq 0$ at x_0

2. Solution of Eulers's equation are known as

(a) Elementary solutions
(b) Euler's solutions
(c) Externals
(d) Primitive solutions

3. An extremal which satisfies the appropriate end conditions is often called a _____ function.

(a) Stationary (b) Extremal
(c) Maximum (d) Minimum

4. Derivative of the variation with respect to an independent variable is _____ the variation of derivative.

(a) Opposite (b) Same as
(c) Reciprocal (d) Twice

5. The degree of freedom for the compound pendulum is

(a) 1 (b) 2
(c) 3 (d) 4

6. The stationary function for an integral function is one for which the variation of integral is

(a) 0 (b) 1
(c) –1 (d) ∞

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7. An integral equation is an equation
   (a) involving
   (b) involving derivative of function
   (c) in which a function to be determined appears under an integral sign
   (d) in which a function to be determined appears as a difference of two functions

8. Volterra equation become integral equation of first kind if _____.
   (a) $\alpha \equiv 0$ (b) $\alpha \equiv 1$
   (c) $\alpha \equiv -1$ (d) $\alpha \equiv y$

9. The differential operator Z is given by
   (a) $\frac{d}{dx}\left(p\frac{d}{dx}\right)+q$ (b) $\frac{d}{dx}(p)+\frac{d}{dx}(q)$
   (c) $\frac{d}{dx}\left(p\frac{d}{dx}\right)$ (d) $p\frac{d^2}{dx^2}+\frac{dp}{dx}+q$

10. If a function $F(x)$ is identically zero in $y(x)=F(x)+\lambda\int_a^b K(x,\xi)y(\xi)d\xi$, the integral equation is said to be _____.
   (a) Non homogeneous (b) Homogeneous
   (c) Linear (d) Constant

11. If $F=1+x+y+y^2$, $y=\sin x$, $dx=\varepsilon$ then dF for $x=0$ is
   (a) 0 (b) $\in$
   (c) $2\in$ (d) $3\in$

12. The determinant $\Delta=|I-\lambda A|$ vanishes then the b integral equation $y(x)=F(x)+\lambda\int_a^b K(x,\xi)y(\xi)d\xi$, has _____ solution.
   (a) only one solution
   (b) infinitely many solution
   (c) no solution
   (d) finite

13. The characteristic numbers of a Fredholm equation with a real symmetric kernel are all _____.
   (a) real (b) zero
   (c) imaginary (d) integers

14. The Kernel $K(x,\in)=\sin x\cos\in$ has _____ characteristic numbers associated with $(0, 2\pi)$.
   (a) no (b) single
   (c) double (d) triple

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15. A Fredholm equation with a non symmetric kernel process characteristic numbers which are not

(a) real (b) zero

(c) imaginary (d) integers

PART B — (5 × 4 = 20 marks)

Answer ALL questions, choosing either (a) or (b).
Each answer should not exceed 250 words.

16. (a) Explain about Lagrange multipliers.

Or

(b) Determine the point on the curve of intersection of the surfaces $z = xy + 5$, $x + y + z = 1$ which is nearest the origin.

17. (a) Explain about the variational notation.

Or

(b) Derive the equation of motion for simple pendulum.

18. (a) Write the definition and properties of Green's function.

Or

(b) Transform the problem $y'' + xy = 1$, $y(0) = 0$, $y(l) = 1$ to an integral equation.

19. (a) Discuss about the influence function.

Or

(b) Define the separable Kernel and give an example.

20. (a) Show that the characteristic numbers of a Fredholm equation with a real symmetric kernel are all real.

Or

(b) Determine the continuous solution of non homogeneous Fredholm equation of second kind.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b)
Each answer should not exceed 600 words.

21. (a) Derive Euler's equation.

Or

(b) Obtain the partial differential equation satisfied by the equation of a minimal surface.

22. (a) Derive specializations of Green's theorem.

Or

(b) Derive the Hamilton's principal in its most general form as applied to the motion of a single particle.

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23. (a) Derive relations between differential and integral equations.

Or

(b) Derive Fredholm equation of second kind.

24. (a) Prove that any solution of

$$y(x)=\lambda\int_0^1(1-3x\in)y(\in)d\in+F(x)$$

can be expressed as the sum of $F(x)$ and some linear combination of the characteristic functions.

Or

(b) Solve Fredholm equations with separable kernels.

25. (a) Derive Hilbert - Schmidt theory.

Or

(b) Explain the method of solving integral equation of the second kind by a method of successive approximations.

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(7 pages) Reg. No. : .....

Code No. : 7414 **Sub. Code : WMASE 32/ VMASE 32**

M.Sc. (CBCS) DEGREE EXAMINATION, NOVEMBER 2025.

Third Semester

Mathematics

Skill Enhancement Course II — R-PROGRAMMING

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — (15 × 1 = 15 marks)

Answer ALL questions.

Choose the correct answer :

1. The major part(s) of the R language software is (are) ————————.

   (a) the base system

   (b) packages

   (c) both (a) and (b)

   (d) neither (a) nor (b)

2. SPSS stands for ————————.

   (a) Social Package for Statistical Sciences

   (b) Scientific Package for Social Statistics

   (c) Statistical Package for Science and Society

   (d) Statistical Package for Social Sciences

3. The user can clear the screen of the console using ————————.

   (a) ctrl + c (b) ctrl + l

   (c) ctrl + r (d) ctrl + d

4. The output of the command >sqrt(–17) is ————————.

   (a) [1] –4 (b) [1] 4.123 i

   (c) [1] 4 (d) [1] NaN

5. To create vectors, ———————— function is used in R.

   (a) v( ) (b) p( )

   (c) c( ) (d) vct( )

6. Which of the following is not a built-in function of R?

   (a) Sum( ) (b) Add( )

   (c) Max( ) (d) Mean( )

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7. To add a vector to the column side of the data frame, ———— function is used.

(a) merge( ) (b) rbind( )

(c) cbind( ) (d) cadd( )

8. Which function performs sorting on a data frame?

(a) str( ) (b) sort( )

(c) merge( ) (d) order( )

9. Which loop performs infinite times when used without break statement?

(a) for (b) while

(c) repeat (d) all the above

10. The script file is saved with ———— extension.

(a) .r (b) .RData

(c) .CSV (d) .rput

11. Which is the full form of CSV?

(a) Common Separate Values

(b) Console Separate Values

(c) Comma Separated Values

(d) Command Separated Values

12. Which operator is not used as a delimiter in CSV file?

(a) comma (,) (b) colon (:)

(c) semicolon (;) (d) all the above

13. A built-in graphical package of R is ————.

(a) grid (b) plot

(c) methods (d) stats

14. To have stair steps on plot as graph type, the type argument used is ————.

(a) S (b) c

(c) s (d) n

15. The built-in function ———— creates a probability chart.

(a) qqnorm( ) (b) pairs ( )

(c) probchart( ) (d) boxplot( )

PART B — ($5 \times 4 = 20$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Write the characteristics of R-language.

Or

(b) Describe the working of R-programming in R-console.

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17. (a) Define function. Also list all string functions which are built-in functions of R.

Or

(b) Explain about logical operators used in R.

18. (a) How switch statement is used in R-programming? Explain with suitable example.

Or

(b) What is a data frame? How is it created in R?

19. (a) Explain the method of importing data from CSV file.

Or

(b) Write a note on SAS software.

20. (a) Write about graphical packages of R-language. Also explain two basic groups of plotting commands.

Or

(b) Explain about box plot.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

21. (a) How to get start with R? Explain the installing process and working in console.

Or

(b) What are the basic rules used in R-commands?

22. (a) Write about the creation and usage of variance types of functions in R.

Or

(b) Discuss about vectors and arithmetic operations on vectors, logical vectors and character vectors.

23. (a) Briefly explain various decision making statements used in R-language.

Or

(b) List all functions that are useful to handle data frames in R.

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24. (a) Explain in detail how to import and export data via ODBC.

Or

(b) How are the data saved and loaded in R language? Explain.

25. (a) Explain in detail the various methods of plots used in R.

Or

(b) Explain how to adjust axes, specify colors, fonts, sizes in R language using graphical packages.

———————

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(7 pages) **Reg. No. :** .....

Code No. : 7411 **Sub. Code : WMAE 32/ VMAE 32**

M.Sc. (CBCS) DEGREE EXAMINATION, NOVEMBER 2025.

Third Semester

Mathematics – Core

Elective V — MATHEMATICAL PYTHON THEORY

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — (15 × 1 = 15 marks)

Answer ALL questions.

Choose the correct answer :

1. A ———— is a block of organized, reusable code that is used to perform a single, related action.

(a) quality (b) function

(c) flow chart (d) state

2. Transition from one process to another process under specified condition with in a time is called ————.

(a) function (b) sequence

(c) state (d) control flow

3. ———— is a single action in a computer.

(a) statement (b) state

(c) algorithm (d) flow chart

4. A function that calls itself is known as ————.

(a) iteration (b) pseudocode

(c) loop (d) recursion

5. The first step in problem solving is ————.

(a) understanding the problem

(b) developing algorithm

(c) listing the possible outcomes

(d) identifying the problem

6. The process of ———— problem solving involves understanding the problem, designing a solution and writing the solution.

(a) computational (b) algorithm

(c) function (d) iteration

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7. All keywords in python are in _____.

(a) upper case (b) lower case

(c) capitalized (d) none of these

8. What is the output of this expression 3*1**3?

(a) 27 (b) 9

(c) 3 (d) 1

9. Which of the following is the correct extension of the python file?

(a) .py (b) .python

(c) .pl (d) .p

10. Which keyword is used for function?

(a) fun (b) def

(c) function (d) define

11. What will be the output of the following python code?

```
x = "abcdef"
i = "a"
while i in x;
    x = x [1:]
    print (i, end = " ")
```

(a) a a a a a a (b) a

(c) no output (d) error

12. Program code making use of a given module is called a _____ of the module.

(a) client (b) interface

(c) docstring (d) modularity

13. What will be the output of the following python code?

```
>>>t = (1, 2, 4, 3)
>>>t [1 : –1]
```

(a) (1, 2) (b) (1, 2, 4)

(c) (2, 4) (d) (2, 4, 3)

14. What will be the output of the following python statement?

```
>>> " abcd " [2:]
```

(a) a (b) ab

(c) cd (d) dc

15. Suppose list1 is [3, 5, 25, 1, 3]. What is min(list1)?

(a) 3 (b) 5

(c) 25 (d) 1

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PART B — (5 × 4 = 20 marks)

Answer ALL the questions by choosing either (a) or (b).

16. (a) What are the characteristics of algorithm?

Or

(b) Distinguish between algorithm and program.

17. (a) State the rules for writing pseudo code.

Or

(b) Write an algorithm to find the greatest of two given numbers.

18. (a) Compose the importance of indentation in python.

Or

(b) How the input function works in Python?

19. (a) Name the type of Boolean operators.

Or

(b) Explain the significance of for loop with else.

20. (a) Explain about string slicing with examples.

Or

(b) Give the difference between list and tuple.

PART C — (5 × 8 = 40 marks)

Answer ALL the questions by choosing either (a) or (b).

21. (a) Discuss about problem solving techniques.

Or

(b) Explain about statement, state and control flow.

22. (a) Discuss about simple strategies for developing algorithms.

Or

(b) Develop an algorithm, Pseudocode and flowchart to find simple interest.

23. (a) Explain interpreter and interactive mode in Python.

Or

(b) Explain about various statements in python.

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24. (a) Write a Python program to find the sum of first n natural numbers.

Or

(b) Describe the syntax and rules involved in return statement.

25. (a) Discuss the Python list methods with examples.

Or

(b) Explain the basic tuples with examples.

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