Reg. No. : .....

(7 pages)

Code No. : 20322 E **Sub. Code : EMMA 51**

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

Fifth Semester

Mathematics – Core

ABSTRACT ALGEBRA

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. An element $a \in G$ is called ———— if $a^2 = a$.
   (a) Idempotent (b) Nil potent
   (c) Involuntory (d) None

2. A subgroup of a cyclic group is ————.
   (a) Abelian (b) Cyclic
   (c) Normal (d) None

3. Every group of prime order is ————
   (a) Cyclic (b) Normal subgroup
   (c) Abelian group (d) None

4. A subgroup H of G is called a normal subgroup of G if ———— for all $a \in G$.
   (a) $aH = H$ (b) $aH = bH$
   (c) $aH = Ha$ (d) None

5. ———— preserves the order of each element in a group.
   (a) Homomorphism (b) Isomorphism
   (c) Epimorphism (d) Monomorphism

6. A homomorphism of a group to itself is called an ————.
   (a) Endomorphism (b) Epimorphism
   (c) Monomorphism (d) None

7. In $M_2(R)$, all the non-singular elements are ————.
   (a) Identity element (b) Zero element
   (c) Units (d) None

8. A commutative skew field is called a ————.
   (a) Field (b) Integral domain
   (c) Ring (d) None

9. An ideal M is called _____ ideal of R there is no proper ideal of R properly containing M.

(a) Prime

(b) Maximal

(c) Neither prime nor maximal

(d) None

10. The homomorphic image of an integral domain is _____.

(a) Integral domain

(b) Need not be an integral domain

(c) Field

(d) None

PART B — ($5 \times 5 = 25$ marks)

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

11. (a) Prove that identity and inverse element of a group is unique.

Or

(b) Prove that a symmetric group of order n contains $n!$ elements.

12. (a) Let G be a group and a be an element of order n in the group G, then $a^m = e$ iff n divides m.

Or

(b) Let H be a subgroup of a group G. Then prove that the number of left cosets of H is same as the number of right cosets of H.

13. (a) Let $f: G \to G'$ be an isomorphism. If G is cyclic then prove that G' is also cyclic.

Or

(b) Let $f: G \to G'$ be a homomorphism then prove that if H is a subgroup of G then $f(H)$ is a subgroup of G'.

14. (a) Prove that $(Z_n, \oplus, \odot)$ is a Ring.

Or

(b) Prove that a ring R has no zero divisors of and only if cancellation law is valid in R.

15. (a) Let R be a Ring and I be a sub group of $(R, +)$. Then prove that multiplication on R/I is given by $(I + a)(I + b) = I + ab$ is well defined iff I is an ideal of R.

Or

(b) Define Maximal and Prime ideals and give examples for each.

PART C — (5 × 8 = 40 marks)

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

Each answer should not exceed 600 words.

16. (a) Let G be the set of all real no's except -1. Define $*$ on G by $a * b = a + b + ab$ then prove that $(G, *)$ is a group.

Or

(b) Define a permutation on the set A and prove that any permutation can be expressed as a product of transpositions.

17. (a) Let G be a group and $a, b \in G$ then prove the following.

(i) Order of a = Order of a^{-1}

(ii) Order of a = Order of $b^{-1}ab$

(iii) Order of ab = Order of ba

Or

(b) Let N be a subgroup of G, then the following are equivalent.

(i) N is a normal subgroup of G

(ii) $aNa^{-1} = N \ \forall \ a \in G$

(iii) $aNa^{-1} \subseteq N \ \forall \ a \in G$

(iv) $aNa^{-1} \in N \ \forall \ n \in N, a \in G$

18. (a) Let $f : G \to G'$ be an isomorphism then

(i) $f(e) = e'$ where e, e' are the identity elements of G and G' respectively

(ii) $f(a^{-1}) = (f(a))^{-1} \ \forall \ a \in G$

Or

(b) For any Group G.

(i) $Aut\ G$ is a group under composition of function.

(ii) $I(G)$ is a normal subgroup of $Aut\ (G)$

19. (a) Prove that $Z \times R$ is a Ring with identity.

Or

(b) (i) Let R be a ring with identity. If I is an ideal of R and $I \in I$ then prove that $I = R$.

(ii) Prove that a field has no proper ideals.

20. (a) Let R and R' be two rings and $f: R \to R'$ be a homomorphism then prove

(i) If S is a subring of R then $f(s)$ is a subring of R'.

(ii) If S is an ideal of R then $f(s)$ is an ideal of $f(R)$.

Or

(b) Define field of quotients and prove that the field quotients μ of an integral domain D is the smallest field containing D.

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Code No. : 20323 E **Sub. Code : EMMA 52**

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

Fifth Semester

Mathematics – Core

REAL ANALYSIS

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. If R with discrete metric, diameter of $[2,5]$ is

(a) 0 (b) 1

(c) 3 (d) 5

2. The diameter of an empty set is

(a) 0 (b) ∞

(c) $-\infty$ (d) 1

3. In R with usual metric if $A = \left\{\frac{1}{n} / n \in z\right\}$ then $\overline{A} =$

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

(c) $(0,1]$ (d) $\{0\} \cup A$

4. In R with usual metric, $B(1,1)$ is

(a) ϕ (b) $[0,2]$

(c) $(0,2)$ (d) $[0,2)$

5. If A is dense then

(a) A^c is dense

(b) A^c is not dense

(c) $\overline{A} = A$

(d) the interior of A is an empty set

6. Let $f:(M_1,d_1) \to (M_2,d_2)$, f is continuous at $a \Leftrightarrow \lim_{x \to a} f(x) =$ _____.

(a) $f(x)$ (b) 0

(c) 1 (d) $f(a)$

7. Q is

(a) open (b) closed

(c) not connected (d) complete

8. If M is connected then every continuous function $f : M \to \{0, 1\}$ is

(a) onto (b) not onto

(c) $1-1$ (d) not $1-1$

9. A subset A for R is compact iff A is a _____ set.

(a) closed

(b) bounded

(c) open

(d) closed and bounded

10. A compact subset of R is

(a) $(0, 1)$ (b) 2

(c) Q (d) a finite set

PART B — ($5 \times 5 = 25$ marks)

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

Each answer should not exceed 250 words.

11. (a) Consider R^n. Let $p > 1$. Define $d(x, y) = \left\{ \sum_{i=1}^{n} |x_i - y_i|^p \right\}^{1/p}$. Prove that d is a metric.

Or

(b) Prove that in a complete metric space a subset A is complete if and only if A is closed.

12. (a) In any metric space prove that arbitrary intersection of closed sets is closed.

Or

(b) Let (M, d) be a metric space and $A \subseteq M$. Prove that x is a limit point of A iff every open ball with center at x contains infinitely many points of A.

13. (a) Prove that f is continuous if and only if inverse image of every open set is open.

Or

(b) Let (M_1,d_1) and (M_2,d_2) be two metric spaces. Prove that a function $f: M_1 \to M_2$ is continuous iff $f^{-1}(F)$ is closed in M_1 whenever F is closed in M_2.

14. (a) Define a connected space. Prove that any discrete metric space with more than one point is disconnected.

Or

(b) If A and B are connected subsets of a metric space M and if $A \cap B = \phi$. Prove that $A \cup B$ is connected.

15. (a) Show that the continuous image of a compact metric space is compact.

Or

(b) Prove that a subset A of R is compact if and only is A is closed and bounded.

PART C — ($5 \times 8 = 40$ marks)

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

16. (a) State and prove Cantor's intersection theorem.

Or

(b) Let (M,d) be a metric space. Define $d_1(x,y) = \dfrac{d(x,y)}{1+d(x,y)}$ prove that d_1 is a metric on M.

17. (a) Prove that l_2 is complete.

Or

(b) Prove : f is continuous $\Leftrightarrow$ inverse image of open set is open.

18. (a) Let A be a non empty subset of a metric space M. Then prove that $\overline{A} = A \cup D(A)$.

Or

(b) If (M_1,d_1) and (M_2,d_2) are two metric spaces, then prove that $f: M_1 \to M_2$ is continuous $\Leftrightarrow f(\overline{A}) \subseteq \overline{f(A)}$, $A \subseteq M_1$.

19. (a) Let M be a metric space and let A be a connected subset of M. If B is subset of M such that $A \subseteq B \subseteq \overline{A}$. Prove that B is connected.

Or

(b) Prove that a subspace of R is connected iff it is an interval.

20. (a) Prove that a compact subset of a metric space is closed and bounded.

Or

(b) State and prove Heine Borel theorem.

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Code No. : 20324 E Sub. Code : EMMA 53

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

Fifth Semester

Mathematics — Core

MATHEMATICAL MODELLING

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. To estimate the mass of Earth _____ can be used.
   (a) mathematical modelling
   (b) Global balance
   (c) Imaginary balance
   (d) Another planet

2. The equation representing that after five years father's age will be thrice the son's age is _____.
   (a) $3x = y+5$ (b) $x = 3y+5$
   (c) $x+5 = 3(y+5)$ (d) $x-5 = 3(y-5)$

3. If there is only one independent variable, then the mathematical model contains _____ equation.
   (a) an ordinary differential
   (b) partial differential
   (c) linear
   (d) quadratic

4. $\frac{dz}{dt} = K\left(A-\frac{az}{a+b}\right)\left(B-\frac{bz}{a+b}\right)$ is the differential equation for a _____ order chemical reaction.
   (a) first (b) second
   (c) third (d) fourth

5. In a simple epidemic model, $\lim_{t\to\infty}\delta(t) =$ _____.
   (a) n (b) 1
   (c) 0 (d) $n+1$

6. If the population of one species is initially zero, it _____.

(a) increases

(b) decreases

(c) increases very slowly

(d) always remains zero

7. In finding the probability of n persons in a queue, the independent variable is _____.

(a) discrete (b) continuous

(c) constant (d) zero

8. The complementary function of the difference equation $x_{t+2} - 4x_{t+1} + 4x_t = 0$ is _____.

(a) $c_1 + c_2 t$ (b) $(c_1 + c_2 t)2^t$

(c) $(c_1 + 2t)\lambda^t$ (d) 2^t

9. _____ is an assumption in the cobweb model.

(a) $q_t = \alpha + \beta p_{t+1}$ (b) $q_t = \alpha + \beta p_t$

(c) $q_{t-1} = \alpha + \beta p_t$ (d) $q_t = \alpha + \beta p_{t-1}$

10. Actuarial science is _____.

(a) mathematics of finance

(b) mathematics of investment

(c) mathematics of statistics and probability

(d) all of these

PART B — ($5 \times 5 = 25$ marks)

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

11. (a) Show that of all rectangles with a given area, the square has the minimum perimeter.

Or

(b) A random sample of 100 light bulbs is found to have a mean life span of 200 hours and a standard deviation of 10 hours. What can you say about the bulbs in the factory?

12. (a) Explain the growth of science and the number of scientists using mathematical modelling.

Or

(b) Write a short note on constructing mathematical modellings through differential equations.

13. (a) Build a simple epidemic model.

Or

(b) Integrate the equation $\frac{dI}{dt} = \beta C_0 N \exp(-\alpha t) - [\beta C_0 \exp(-\alpha t) + \gamma] I$ and find $\lim_{t \to \infty} I(t)$.

14. (a) Solve : $x_{t+2} - 7x_{t+1} + 12x_t = 0$.

Or

(b) List any three mathematical modelling involving difference equations.

15. (a) What are the assumption made in the Harrod model?

Or

(b) If both the roots of the equation $m^2 + a_1 m + a_2 = 0$ are less than unity in absolute magnitude, then show that $1 + a_1 + a_2 \geq 0, 1 - a_1 + a_2 > 0, 1 - a_2 > 0$.

PART C — (5 × 8 = 40 marks)

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

16. (a) The angles of elevation of the foot and the top of a flag-post on a tower, from a point 'a' metre from the foot tower are α and β respectively. Show that the height of the flag-post is $a(\tan\beta - \tan\alpha)$ metre.

Or

(b) Explain any four characteristics of mathematical models.

17. (a) Describe the population growth models.

Or

(b) How do we measure the diffusion of glucose in the blood stream?

18. (a) Discuss the prey-predator model.

Or

(b) Prepare a model for diabetes mellitus.

19. (a) Describe the method of finding complementary function of a linear difference equation.

Or

(b) Solve : $x_{t+2} - 4x_{t+1} + 3x_t = t$.

20. (a) What is acturial science? What is its application?

Or

(b) Write the mathematical formulation of the cobweb model.

Reg. No. : .....

Code No. : 20334 E **Sub. Code : EEMA 51**

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

Fifth Semester

Mathematics

Elective — OPERATIONS RESEARCH – I

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. Given a system of m linear equations in n unknowns, $m < n$, the number of basic variables will be _____

(a) m (b) n

(c) $n - m$ (d) $n + m$

2. Graphical solution method is also called _____ method

(a) search approach (b) straight line

(c) $x - y$ (d) short cut

3. For maximization linear programming problem, the simplex method is terminated when all the net evaluations are _____

(a) negative (b) zero

(c) non-negative (d) non-zero

4. If a constraints is of $\geq$ type, we introduce _____ variable

(a) slack (b) surplus

(c) random (d) basic

5. Dual simplex method is applicable to the LPP that starts with _____ solution

(a) an infeasible

(b) a feasible

(c) an infeasible but optimum

(d) a feasible and optimum

6. If the given LPP is in its standard form, the primal - dual pair is said to be _____

(a) symmetric (b) unsymmetric

(c) feasible (d) infeasible

7. The general transportation problems _____

(a) always have a solution

(b) need not have a solution

(c) have no solution

(d) sometimes be unsolved

8. When the total demand is _____ total supply, the transportation problem is called balanced

(a) less than (b) greater than

(c) not equal to (d) equal to

9. _____ method is an efficient method for solving assignment problem

(a) complete enumeration

(b) simplex

(c) transportation

(d) hungarian

10. Assignment problem cannot be solved using _____ method

(a) simple
(b) complete enumeration
(c) transportation
(d) graphical

PART B — (5 × 5 = 25 marks)

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

11. (a) Write the basic assumptions which are necessary for linear programming problems.

Or

(b) Show that the following system of linear equations has a degenerate solution $2x_1 + x_2 - x_3 = 2$, $3x_1 + 2x_2 + x_3 = 3$.

12. (a) State the computational procedure of revised simplex method.

Or

(b) Show that the following LPP does not possess any feasible solution :

Maximize : $z = 3x_1 + 2x_2$

Subject to the constraints :

$2x_1 + x_2 \leq 2$, $3x_1 + 4x_2 \geq 12$,

$x_1, x_2 \geq 0$.

13. (a) Write the Dual of the LPP :

Minimize $z = 4x_1 + 6x_2 + 18x_3$

Subject to the constraints

$x_1 + 3x_2 \geq 3$,

$x_2 + 2x_3 \geq 5$,

$x_1, x_2, x_2 \geq 0$.

Or

(b) Prove that the dual of the dual is primal.

14. (a) Explain the matrix minima method.

Or

(b) Using North-West corner rule obtain an initial basic feasible solution for the following transportation problem :

	D_1	D_2	D_3	D_4	Supply
O_1	5	3	6	2	19
O_2	4	7	9	1	37
O_3	3	4	7	5	34
Demand	16	18	31	25	

15. (a) Write the steps involved in Hungarian method.

Or

(b) Convert the following assignment problem into a transportation problem.

	A	B	C
1	120	100	80
2	80	90	110
3	110	140	120

PART C — ($5 \times 8 = 40$ marks)

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

16. (a) Use graphical method to solve the following LPP:

Maximize : $z = 9x_1 + 3x_2$

Subject to the constraints :

$5x_1 + 2x_2 \leq 20$,

$x_1 \geq 3$, $x_2 \leq 5$, $x_1, x_2 \geq 0$.

Or

(b) Rolls of paper having a fixed length and width of 180 cm are being manufactured by a paper mill. These rolls have to be cut as per the following demand :

Width :	80 cm	45 cm	27 cm
No. of. rolls :	200	120	130

Formulate a linear programming problem to determine the cutting pattern, so that the demand is satisfied and wastage of paper is a minimum.

17. (a) Use simplex method to solve the LPP :

Maximize : $z = 4x_1 + 10x_2$

Subject to the constraints :

$2x_1 + x_2 \leq 50$,

$2x_1 + 5x_2 \leq 100$,

$2x_1 + 3x_2 \leq 90$,

$x_1 \geq 0$, $x_2 \geq 0$.

Or

(b) Use Big-M method to solve the LPP :

Maximize : $Z = 6x_1 + 4x_2$

Subject to the constraints :

$2x_1 + 3x_2 \leq 30$,

$3x_1 + 2x_2 \leq 24$, $x_1 + x_2 \geq 3$,

$x_1 \geq 0$, $x_2 \geq 0$.

18. (a) Apply dual simplex method to solve the following LP :

Minimize : $Z = 3x_1 + x_2$

Subject to the constraints :

$x_1 + x_2 \geq 1$, $2x_1 + 3x_2 \geq 2$, $x_1, x_2 \geq 0$.

Or

(b) Write the steps involved in the formulation of a dual to the primal problem.

19. (a) Find an initial basic feasible solution for the following transportation problem using Vogel's approximation method.

	D_1	D_2	D_3	D_4	Supply
S_1	3	7	6	4	5
S_2	2	4	3	2	2
S_3	4	3	8	5	3
Demand	3	3	2	2	

Or

(b) Explain the stepping stone solution method.

20. (a) Evaluate the minimum cost is the following assignment problem.

	E	F	G	H
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

Or

(b) Compute the maximum profit in the following assignment problem :

	A	B	C	D
P	140	112	98	154
Q	90	72	63	99
R	110	88	77	121
S	80	64	56	88

(6 pages)

Reg. No. : .....

Code No. : 20337 E **Sub. Code : EEMA 54**

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

Fifth Semester

Mathematics

Elective — FUZZY SETS AND APPLICATIONS

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. The value of $A \cup \overline{A}$ is

(a) A (b) $\overline{A}$

(c) ϕ (d) X

2. The set $\{x / A(x) \geq \alpha\} =$

(a) $\alpha + A$ (b) αA

(c) $\wedge(A)$ (d) $h(A)$

3. Which one of the following is not true

(a) $\alpha + A \subseteq \alpha A$

(b) $\alpha A \subseteq \alpha + A$

(c) $\alpha(A \cap B) = \alpha A \cap \alpha B$

(d) $(A \cup B) = \alpha A \cup \alpha B$

4. If $A, B \in \mathcal{F}(x)$, then for all $\alpha \in [0,1]$, $A \subseteq B$ iff

(a) $\alpha A \subseteq \alpha B$ (b) $\alpha A = \alpha B$

(c) $\alpha A \supseteq \alpha B$ (d) None of these

5. $i(a,1) =$

(a) a (b) 1

(c) 0 (d) b

6. $u(a,a)$ is

(a) $< a$ (b) $= a$

(c) $> a$ (d) None of these

7. The value of $[2,5]-[1,3]$ is

(a) $[1,4]$ (b) $[-1,4]$

(c) $[4,1]$ (d) $[4,-1]$

8. Which one of the following is not true

(a) $MIN(A, A) = A$

(b) $MAX(A,A) = A$

(c) $MIN(A,B) = MIN(B, A)$

(d) $MAX(A,B) = MIN(B,A)$

9. The first paper on fuzzy decision making was propared by

(a) Bellman (b) Zadeh

(c) Both (a) and (b) (d) Blin

10. The number of criteria in multicriteria decision making is virtually always assumed to be

(a) Finite (b) infinite

(c) Single (d) Multiple

PART B — ($5 \times 5 = 25$ marks)

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

11. (a) Write a short note on α-cut and strong α-cut.

Or

(b) What are the standard operations on fuzzy?

12. (a) Prove that $\alpha(A \cap B) = \alpha A \cap \alpha B$.

Or

(b) Explain the representations of fuzzy sets.

13. (a) Write the axioms of fuzzy union.

Or

(b) If a complement c has an equilibrium e_c, then prove that $e_{e_c} = e_c$.

14. (a) Explain the linguistic variables.

Or

(b) Explain the arithmetic operations on intervals.

15. (a) Explain the multiperson decision making.

Or

(b) Write a short note on fuzzy linear programming.

PART C — (5 × 8 = 40 marks)

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

16. (a) What are the basic concepts of fuzzy sets? Explain.

Or

(b) Explain the crisp sets.

17. (a) State and prove second decomposition theorem.

Or

(b) Explain the extension principle for fuzzy sets.

18. (a) State and prove first characterization theorem of fuzzy complements.

Or

(b) Explain the fuzzy intersections.

19. (a) Explain arithmetic operations on fuzzy numbers.

Or

(b) Explain the fuzzy equation $A.x = B$.

20. (a) Explain the individual decision making.

Or

(b) Explain the multicriteria decision making.

———————