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

Code No. : 10326 E **Sub. Code : EMMA 61**

B.Sc. (CBCS) DEGREE EXAMINATION,
APRIL 2026.

Sixth Semester

Mathematics – Core

LINEAR ALGEBRA

(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. Which one of the following is not a vector space.
   (a) $R \times R$ over R (b) C over R
   (c) R over C (d) None of these.

2. A linear transformation T is monomorphism if
   (a) T is 1-1 (b) T is onto
   (c) Both (a) and (b) (d) None of these.

3. In R, let $S=\{1\}$, then $L(S)=$
   (a) S (b) C
   (c) R (d) Q

4. $\dim M_2(R)=$
   (a) 1 (b) 2
   (c) 3 (d) 4

5. A linear transformation $T:V \to W$ is called non-singular if
   (a) T is onto (b) T is 1-1
   (c) Both (a) & (b) (d) None of these.

6. The norm $\|x\|=$
   (a) $\langle x, x \rangle$ (b) $\sqrt{\langle x, x \rangle}$
   (c) $(\langle x, x \rangle)^2$ (d) $\langle 1, x \rangle$

7. The rank of the matrix $\begin{pmatrix} 1 & 2 & 2 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$ is
   (a) 1 (b) 2
   (c) 3 (d) 4.

8. The characteristic polynomial of $A=\begin{pmatrix}0 & 1\\ 0 & 0\end{pmatrix}$ is

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

(c) $1-x^2$ (d) $x-1$.

9. The matrix of the quadratic form $ax_1^2+ax_2^2-2bx_1x_2$

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

(c) $\begin{pmatrix}1 & a\\ b & 1\end{pmatrix}$ (d) $\begin{pmatrix}a & -b\\ -b & a\end{pmatrix}$.

10. The product of the eigen values of $\begin{pmatrix}-3 & 3\\ -2 & 4\end{pmatrix}$ is

(a) –6 (b) 6

(c) 0 (d) –12

PART B — (5 × 5 = 25 marks)

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

Each answer should not exceed 250 words.

11. (a) Prove that the intersection of two subspaces of a vertex space is a subspace.

Or

(b) Prove that $R\times R$ is a vector space over R under usual addition and scalar multiplication.

12. (a) Let V be a vector space over F and $S, T \subseteq V$. Prove that $L(S\cup T)=L(S)+L(T)$.

Or

(b) Prove that any subset of a linearly independent set is linearly independent.

13. (a) Obtain the matrix representing the linear transformation $T:V_3(R)\to V_3(R)$ given by $T(a, b, c)=(3a, a-b, 2a+b+c)$ w.r.t. standard basis $\{e_1, e_2, e_3\}$.

Or

(b) State and prove Schwartz's inequality.

14. (a) Find the rank of the matrix $A=\begin{pmatrix}4 & 2 & 1 & 3\\ 6 & 3 & 4 & 7\\ 2 & 1 & 0 & 7\end{pmatrix}$.

Or

(b) Find the characteristic equation of the matrix $A=\begin{bmatrix}1 & 0 & 2\\ 0 & 1 & 2\\ 1 & 2 & 0\end{bmatrix}$.

15. (a) Find the eigen values of A^5 when $A=\begin{bmatrix}3 & 0 & 0\\ 5 & 4 & 0\\ 3 & 6 & 1\end{bmatrix}$.

Or

(b) Find the matrix of the bilinear form $f(x, y)=x_1y_1+x_2y_2$ w.r.t. the standard basis in $V_2(R)$.

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 fundamental theorem of homomorphism.

Or

(b) Prove that the quotient space of V by W is a vector space.

17. (a) Let V be a vector space over F, let $S, T \subseteq V$, then prove that

(i) $S \subseteq T \Rightarrow L(S) \subseteq L(T)$

(ii) $L(S)=S$ iff S is a subspace of V.

Or

(b) Prove that any vector space of dimension n over a field F is isomorphic to $V_n(F)$.

18. (a) Prove that every finite dimensional inner product space has an orthonormal basis.

Or

(b) Let W_1 and W_2 be subspaces of a finite dimensional inner product space. Then prove that $(W_1+W_2)^T = W_1^{\perp} \cap W_2^{\perp}$.

19. (a) State and prove Caylen-Hamilton's theorem.

Or

(b) Using Cayley-Hamilton's theorem for the matrix $A=\begin{pmatrix}1 & 0 & -2\\ 2 & 2 & 4\\ 0 & 0 & 2\end{pmatrix}$ find

(i) A^{-1}

(ii) A^4.

20. (a) Reduce the quadratic form $x_1^2+2x_2^2-7x_3^2-4x_1x_2+8x_1x_3$ to the diagonal form.

Or

(b) Find the eigen values and eigen vector of the matrix $A=\begin{bmatrix}2 & -2 & 2\\ 1 & 1 & 1\\ 1 & 3 & -1\end{bmatrix}$.

(7 pages)

Reg. No. : .....

Code No. : 10327 E **Sub. Code : EMMA 62**

B.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2026.

Sixth Semester

Mathematics — Core

COMPLEX ANALYSIS

(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. $\lim_{z \to 2} \frac{z^2 - 4}{z - 2} =$ _____.

(a) 4 (b) 2

(c) 1 (d) None

2. Complex form of C-R equations are given by _____.

(a) $fx = -fy$ (b) $fx = -ify$

(c) $fx = ify$ (d) $fx = 0$

3. Bilinear Transformations are also called _____ Transformation.

(a) Mobius (b) Jordan

(c) Cross product (d) None

4. The Invarient points of $w = \frac{1+z}{1-z}$ is _____.

(a) $z = i - 1$ (b) $z = -i + 1$

(c) $z = \pm i$ (d) 0

5. By Cauchy's Integral formula, the value of $\int_C \frac{dz}{z-3} =$ _____ where C is the circle $|z - 2| = 5$.

(a) 2π (b) $2\pi i$

(c) $4\pi^2$ (d) $4\pi i$

6. A bounded entire function in the complex plane is _____.

(a) 1 (b) 0

(c) constant (d) none

7. The Harmonic series $\sum \frac{1}{n^p}$ converges if _____.

(a) $p > 1$ (b) $p < 1$

(c) $p = 1$ (d) none

8. The zeros of the function $\cos z$ is _____.

(a) $(2n+1)\pi/2$ (b) $(2n+1)\pi/4$

(c) $2n+1$ (d) 0

9. If $f(z) = \frac{e^z}{z^2}$ then $\text{Res}\{f(z) : 0\} =$ _____.

(a) 1 (b) –1

(c) 0 (d) None

10. $\int_0^{2\pi} \frac{d\theta}{5+3\cos\theta} =$ _____.

(a) π (b) $-\pi/2$

(c) $\pi/2$ (d) $\pi/4$

PART B — (5 × 5 = 25 marks)

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

11. (a) Prove that the function $f(z) = \bar{z}$ is nowhere Differentiable.

Or

(b) Find the constants a and b so that the function $f(z) = a(x^2 - y^2) + ibxy + c$ is differentiable at every point.

12. (a) Let f be an Analytical function defined in a region D. Let $z_0 \in D$. If $f'(z_0) \neq 0$ then prove that f is conformal at z_0.

Or

(b) Prove that any Bilinear Transformation preserves cross ratio.

13. (a) Prove that $\left|\int_C f(z)dz\right| \leq Ml$ where $M = Max\{|f(z)| z \in C\}$ and l is the length of C.

Or

(b) State and prove Fundamental Theorem of Algebra.

14. (a) Find the radius of convergence for the series $\sum_{n=1}^{\infty} \frac{z^n}{n}$.

Or

(b) Find the Laurent's Series Expansion of $f(z) = z^2 e^{1/z}$ about $z = 0$.

15. (a) Calculate the residue of $\frac{z+1}{z^2 - 2z}$ as its poles.

Or

(b) Evaluate $\int_C \frac{e^z dz}{(z+2)(z-1)}$ where C is the circle $|z-1| = 1$.

PART C — (5 × 8 = 40 marks)

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

16. (a) Derive C-R equations in polar co-ordinates.

Or

(b) If $f(z) = u(x, y) + iv(x, y)$ is an analytic function and $u(x, y) = \sin 2x / \cosh 2y + \cos 2x$ then find $f(z)$.

17. (a) Find the image of the strip $2 < x < 3$ under $w = \frac{1}{z}$.

Or

(b) Prove that any Bilinear Transformation having two finite fixed points α and β can be written in the form $\frac{w-\alpha}{w-\beta} = K\left(\frac{z-\alpha}{z-\beta}\right)$.

18. (a) State and prove Cauchy's theorem.

Or

(b) Evaluate $\int_C \frac{e^z dz}{(z+2)(z+1)^2}$ where C is $|z| = 3$.

19. (a) State and prove Taylor's Series.

Or

(b) Define the following with examples :

(i) Removable singularities

(ii) Poles

(iii) Essential Singularities.

20. (a) State and prove Cauchy's Residue Theorem.

Or

(b) Prove that $\int_0^{2\pi} \frac{d\theta}{1+a\sin\theta} = \frac{2\pi}{\sqrt{1-a^2}}$, $-1 < a < 1$.

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

Code No. : 10328 E **Sub. Code : EMMA 63**

B.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2026

Sixth Semester

Mathematics – Core

MECHANICS

(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. The force of attraction of the earth on a body is called

   (a) Gravity

   (b) Weight of the body

   (c) Friction

   (d) Momentum

2. The particle is in equilibrium, then, $\bar{F}_1 + \bar{F}_2 + \bar{F}_3 =$ _____.

   (a) 0 (b) $\hat{n}$

   (c) 1 (d) f

3. A system of particles such that the distance b/w any two of them is always constant is called ——.

   (a) Applied force

   (b) Effective force

   (c) Rigid body

   (d) Momentum

4. Kinetic energy can be written as

   (a) $\frac{1}{2}mV^2$ (b) $\frac{1}{2}m\bar{r}\cdot\bar{r}$

   (c) $\frac{1}{2}\bar{r}$ (d) $\frac{1}{2}\bar{r}^2$

5. The unit of work in M.K.S. System.

   (a) Erg (b) Joule

   (c) Foot (d) Newton

6. 1 watt is ———— joule per second

   (a) 1 (b) 2

   (c) 100 (d) 0.5

7. A particle or body projected is called ————.

(a) Motion (b) Acceleration

(c) Projectile (d) Resistance

8. The path pursued by a projectile is called ——.

(a) Trajectory (b) Momentum

(c) Displacement (d) Range

9. When the path is parabola ————.

(a) $e > 1$ (b) $e < 1$

(c) $e = 0$ (d) $e = 1$

10. The polar equation of the cone is ————.

(a) $\frac{l}{r} = 1 + e\cos\theta$ (b) $\frac{l}{r} = 1 + e\sin\theta$

(c) $\frac{l}{r} = 1 - e\cos\theta$ (d) $\frac{l}{r} = 1$

PART B — (5 × 5 = 25 marks)

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

Each answer should not exceed 250 words.

11. (a) The magnitude of the resultant of two given forces P, Q is R. If Q is doubled, then R is doubled. If Q is reversed, then also R is doubled. Show that $P : Q : R = \sqrt{2} : \sqrt{3} : \sqrt{2}$

Or

(b) Five forces acting at a point are represented in magnitude and direction by the lines joining the vertices of any pentagon to the midpoint of their opposite sides. Show that they are in equilibrium.

12. (a) Prove that, if four forces acting along the sides of a square are in equilibrium, they must be equal in magnitude.

Or

(b) Forces with components $(1,0), (-2,0), (1,1)$ are respectively at the points $(0,0), (1,1), (1,0)$. What is the system equivalent to?

13. (a) The total mass of a train is 500 tonnes. If its maximum speed on the level is 90 k.m.ph. the resistance due to friction being 8 kg.wt. per.tonne. Find the power of the engine.

Or

(b) Show that the superposition of two simple harmonic motions.

14. (a) If V_1 and V_2 are the velocities of a projectile at the ends of a focal chords of its path and V, the horizontal components of its velocity. Show that $\frac{1}{V_1^2} + \frac{1}{V_2^2} = \frac{1}{V^2}$.

Or

(b) Explain horizontal & vertical displacement.

15. (a) If a point moves so that its radical velocity is K times its transverse velocity, show that its path is an equiangular spiral.

Or

(b) Show that the central orbit is a plane curve.

PART C — ($5 \times 8 = 40$ marks)

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

Each answer should not exceed 600 words.

16. (a) The resultant of two forces P, Q is magnitude P. Show that, P is doubled, the new resultant is perpendicular to the force Q and its magnitude is $\sqrt{4p^2 - Q^2}$.

Or

(b) E is the midpoint of the side CD of a square $ABCD$. Forces 16, 20 $4\sqrt{5}, 12\sqrt{2}$ act along $\overline{AB}, \overline{AD}, \overline{EA}, \overline{CA}$. Show that they are in equilibrium.

17. (a) Find the resultant of two parallel forces acting on a rigid body.

Or

(b) State and prove Varignon's theorem.

18. (a) Show that in a conservative field of a force, the force is the gradient of a scalar point function.

Or

(b) Show that, in a simple harmonic motion, the sum of K.E. and P.E. is a constant.

19. (a) Verify in the case of a projectile, K.E+P.E. = constant.

Or

(b) A particle is projected from a point O on the round with a velocity u inclined to the horizontal at an angle α. It hits the ground at A. Find (i) Horizontal range R (ii) Maximum height attained by the particle.

20. (a) The velocities of a particle along and perpendicular to the radius vector are λ_r and $\mu\theta$. Find the path and show that the acceleration components along and perpendicular to the radius vector are

$$\lambda^2 r - \frac{\mu^2\theta^2}{r}, \mu\theta\left(\lambda + \frac{\mu}{r}\right).$$

Or

(b) Obtain the differential equation of central orbit in polar coordinates.

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

Code No. : 10341 E **Sub. Code : EEMA 61**

B.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2026.

Sixth Semester

Mathematics

Elective – OPERATIONS RESEARCH – II

(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. The sequencing problems in operation research mainly deals with _____.

   (a) allocation of resources

   (b) determining the order of jobs on machines

   (c) transportation of goods

   (d) replacement of machines

2. A sequencing problem involving six jobs and three machine requires evaluation of _____.

   (a) $(6!+6!+6!)$ (b) $(6!)^3$

   (c) $(6\times6\times6)$ (d) $(6+6+6)$

3. In critical path analysis, CPM is _____.

   (a) event oriented

   (b) dynamic in nature

   (c) probabilistic in nature

   (d) deterministic in nature

4. The slack for an activity in network is equal to

   (a) LS – ES (b) LF – LS

   (c) EF – LS (d) EF – ES

5. A mixed strategy game can be solved by _____.

   (a) matrix method (b) algebraic method

   (c) graphical method (d) all the above

6. When there are two competitors playing a game is called _____.

   (a) n-person game (b) two-person game

   (c) biased game (d) all the above

7. For a "poisson exponential, single server infinite population" queuing model, which is not correct?

(a) $E(n) = E(m) - \lambda/\mu$

(b) $E(m) = \lambda E(w)$

(c) $E(n) = \lambda E(v)$

(d) $E(v) = E(w) + 1/\mu$

8. Multiple servers may be _____.

(a) in parallel (b) in series

(c) both (a) and (b) (d) all the above

9. The unit cost rises, will optimum order quantity

(a) increases

(b) decreases

(c) either increase or decrease

(d) none of these

10. If EOQ is calculated, but an order is then placed which is smaller than this, will there be total inventory cost?

(a) increases

(b) decreases

(c) either increase or decrease

(d) no change

PART B — (5 × 5 = 25 marks)

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

11. (a) A company has six jobs on hand coded 'A' to 'F'. All the jobs have to go through two machines "M1" and "M2". The time required for each jobs on each machine in hours is given :

	A	B	C	D	E	F
M1	3	12	18	9	15	6
M2	9	18	24	24	3	15

Draw a sequence table scheduling the six jobs on two machines.

Or

(b) Write the optimum sequence algorithm.

12. (a) A project has the following activities and other characteristics :

Activity	Preceding activity	Time Estimates (in weeks)		
		Most likely	Optimistic	Pessimistic
A	–	5	4	6
B	–	12	8	16
C	A	5	4	12
D	B	3	1	5
E	D, A	2	2	2
F	B	5	4	6
G	C, E, F	14	10	18
H	G	20	18	34

(i) Draw the PERT network diagram.

(ii) Identify the critical path

(iii) Find the probability that the project completed in 56 weeks.

Or

(b) Write the rules of network construction.

13. (a) Solve the following 2-person zero sum game :

Player B

$$\text{Player A} \begin{bmatrix} -2 & 12 & -4 \\ 1 & 4 & 8 \\ -5 & 2 & 3 \end{bmatrix}$$

Or

(b) Solve the following game graphically.

B

$$A \begin{bmatrix} -2 & 0 \\ 3 & -1 \\ -3 & 2 \\ 5 & -4 \end{bmatrix}$$

14. (a) Explain about Inter Arrival Times (Exponential Process).

Or

(b) Write the characteristics of model (M/M/1) : (∞/FIFO).

15. (a) Explain the problem of EOQ with one price break.

Or

(b) Write the types of inventories.

PART C — ($5 \times 8 = 40$ marks)

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

16. (a) Use graphic method to find the minimum elapsed total time sequence of 2 jobs and 4 machines.

Job 1	Sequence	A	B	C	D
	Time	2	4	5	1
Job 2	Sequence	D	B	A	C
	Time	6	4	2	3

Or

(b) Solve the following sequencing problem when passing out is not allowed.

Item	Machine (time in hours)			
	A	B	C	D
I	15	5	4	15
II	12	2	10	12
III	16	3	5	16
IV	17	3	4	17

17. (a) A project has the following schedule :

Activity	Time in weeks	Activity	Time in weeks
1 – 2	2	4 – 6	3
1 – 3	2	5 – 8	1
1 – 4	1	6 – 9	5
2 – 5	4	7 – 8	4
3 – 6	8	8 – 9	3
3 – 7	5		

(i) Construct PERT network

(ii) Compute critical path and its duration.

Or

(b) Explain logical sequencing.

18. (a) Explain about the MAXIMIN-MINIMAX principle.

Or

(b) Solve the following 2-person zero sum game :

Player A	Player B		
	B_1	B_2	B_3
A_1	15	10	4
A_2	10	–3	10
A_3	12	23	0

19. (a) Write the characteristics of model (M/M/1) : (N/FIFO).

Or

(b) Explain waiting time distribution for model (M/M/1) : (∞/FIFO).

20. (a) Explain costs associated with inventories.

Or

(b) Explain the fundamental problem of EOQ.

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

Code No. : 10342 E **Sub. Code : EEMA 62**

B.Sc. (CBCS) DEGREE EXAMINATION,
APRIL 2026.

Sixth Semester

Mathematics

Elective – GRAPH THEORY

(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. In a graph G, if a vertex has a degree of 1, it is specifically referred to as a

(a) Isolated vertex (b) Pendent vertex

(c) Null vertex (d) Critical vertex

2. Which of the following is a necessary and sufficient condition for a graph to be an Euler graph?

(a) Every vertex must have an odd degree

(b) The graph must be disconnected

(c) Every vertex must have an even degree

(d) It must contain a Hamiltonian circuit.

3. A path in which the first and last vertices are the same, and no edges are repeated, is called a

(a) Walk (b) Trail

(c) Circuit (d) Spanning Tree

4. How many edges are there in a Tree with n vertices?

(a) n (b) $n+1$

(c) $n-1$ (d) $2n$

5. In an Incidence Matrix (A) of a graph with n vertices and e edges, the sum of the entries in any column is always

(a) 1 (b) 2

(c) 0 (d) n

6. Which of these matrices is a (0, 1)-matrix of size $n \times n$, where the entry a_{ij} is 1 if there is an edge between vertex v_i and v_j ?

(a) Incidence Matrix

(b) Path Matrix

(c) Circuit Matrix

(d) Adjacency Matrix

7. Kuratowski's Two Graphs (K_5 and $K_{3,3}$) are significant because they are

(a) The only Euler graphs

(b) Non-planar graphs

(c) Always Hamiltonian

(d) Complete Bipartite graphs only

8. According to Euler's formula for a planar connected graph, if n is the number of vertices, e is the number of edges, and f is the number of faces, then

(a) $n-e+f=2$ (b) $n+e-f=2$

(c) $e-n+f=1$ (d) $n-e-f=2$

9. The minimum number of colors required to color the vertices of a graph such that no two adjacent vertices have the same color is called the

(a) Matching number

(b) Chromatic polynomial

(c) Chromatic number

(d) Covering number

10. A "Matching" in a graph G is a set of edges such that

(a) All edges meet at a single vertex

(b) No two edges in the set share a common vertex

(c) Every vertex in the graph is covered

(d) It forms a closed circuit

PART B — (5 × 5 = 25 marks)

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

11. (a) Show that the sum of the degrees of all vertices in a graph is twice the number of edges.

Or

(b) Define 'Isomorphism' between two graphs. What are the necessary conditions for two graphs to be isomorphic?

12. (a) Prove that a graph is a Tree if and only if there is a unique path between every pair of vertices.

Or

(b) Define a Spanning Tree. Prove that every connected graph has at least one spanning tree.

13. (a) Define 'Adjacency Matrix' and "Incidence Matrix'. Write down both matrices for a simple triangle graph K_3.

Or

(b) Write a short note on Path Matrices.

14. (a) Prove that the complete graph of five vertices is nonplanar.

Or

(b) Define "Chromatic Number". Explain the steps to find the chromatic polynomial for a path graph P_n with n vertices.

15. (a) Explain the four colour problem.

Or

(b) What are the types of digraphs. Explain.

PART C — ($5 \times 8 = 40$ marks)

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

16. (a) What is the Seating Problem? Explain.

Or

(b) Explain the problem of a puzzle with multicolored cubes.

17. (a) State and prove the necessary and sufficient condition for a graph to be an Euler graph.

Or

(b) Prove that every tree has either one or two centers.

18. (a) If $A(G)$ is an incidence matrix of a connected graph G with n vertices, prove that the rank of $A(G)$ is $n-1$.

Or

(b) If B is a circuit matrix of a connected graph G with e edges and n vertices, prove that rank of $B = e - n + 1$.

19. (a) State and prove Euler's Formula for connected planar graphs.

Or

(b) Explain the chromatic polynomial with an example of any graph.

20. (a) State and prove five color theorem.

Or

(b) What is Teleprinter's problem? Explain.
