Reg. No.															

Question Paper Code	13885

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Third Semester

CIVIL ENGINEERING

(Common to Electrical and Electronics Engineering, Electronics and Instrumentation Engineering & Electronics and Instrumentation Control Engineering)

24BSMA302 – LINEAR ALGEBRA AND PARTIAL DIFFERENTIAL EQUATIONS

Regulations - 2024

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	The dimension of subspace $W = \{(x, y, z) \mid x + y + z = 0\}$ in $\mathbb{R}^3$ is (a) 5 (b) 3 (c) 4 (d) 2	1	K2	CO1
2.	The value of k for which the vector (1, −2, k) in $\mathbb{R}^3$ is a linear combination of the vectors (3, 0, −2), (2, −1, −5) is (a) 8 (b) -8 (c) 0 (d) ±8	1	K2	CO1
3.	LetT:$\mathbb{R}^2 \to \mathbb{R}^2$ by T(a_1,a_2) = (a_1,-a_2). Then T is called the _____about the X-axis. (a) Reflection (b) Projection (c) Reflection (d) Transformation	1	K1	CO2
4.	Let V and W be vector spaces and T:V→W be linear. T is one-one if and only if (a) N(T) = {0} (b) N(T) ⊆ V (c) N(T) = {v} (d) N(T) ≠ {0}	1	K1	CO2
5.	The distance between the vectors (7, 1) and (3, 2) in $\mathbb{R}^2$ using the standard inner product is (a)$\sqrt{14}$ (b) $\sqrt{17}$ (c) $\sqrt{13}$ (d) $\sqrt{11}$	1	K2	CO3
6.	Let V = P($\mathbb{R}$) be the vector space of polynomials over $\mathbb{R}$ with inner product defined by ⟨f, g⟩ = $\int f(t)g(t)\,dt$, -1≤ t ≤ 1. Then ⟨x^2, x⟩ is (a) 1/4 (b) 0 (c) 2/3 (d) 4/3	1	K2	CO3
7.	For any linear operator T on an inner product space, the adjoint operator T^* satisfies (a) $\langle T(u), v\rangle = \langle T^*(v), u\rangle$ (b) $\langle T(u), v\rangle = \langle u, T^*(v)\rangle$ (c) $\langle u, T(v)\rangle = \langle T(u),\ T^*(v)\rangle$ (d) $T^* = T^{-1}$	1	K1	CO4
8.	If Q is an orthogonal matrix in QR-decomposition, then (a) $Q^TQ = I$ (b) $QQ^T = I$ (c) both a and b (d) None of the above	1	K1	CO4
9.	The Lagrange's multipliers for the partial differential equation $px(y - z) + qy(z - x) = z(x - y)$ are (a) 2,3,4 (b) 1,1,1 (c) 3,4,2 (d) 4,2,3	1	K2	CO5
10.	Solve $(D^2 - 5DD' + 6D'^2)z = 0$ (a) $z = f_1(y + 2x) + f_2(y + 3x)$ (b) $z = f_1(y - 2x) + f_2(y + 3x)$ (c) $z = f_1(y + 2x) + f_2(y - 3x)$ (d) $z = f_1(y - 2x) + f_2(y - 3x)$	1	K2	CO6

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

		Marks	K – Level	CO
11.	Define Subspace.	2	K1	CO1
12.	Examine whether $(2, -5, 4)$ can be represented as a linear combination of vectors $(1, -3, 2)$ and $(2, -1, 1)$ in R^3 over R.	2	K2	CO1
13.	State Dimension theorem.	2	K1	CO2
14.	Is there a linear transformation $T: R^3 \to R^2$ such that $T(1,0,3) = (1,1)$ and $T(-2,0,-6) = (2,1)$? Justify your answer.	2	K2	CO2
15.	Let $x =< 2, 1 + i, i >$ and $y =< 2 - i, 2, 1 + 2i >$ be vectors in C^3. Compute $< x, y >$.	2	K2	CO3

16. Find k so that $u = (1,2,k,3)$ and $v = (3,k,7,-5)$ are orthogonal in R^4 with standard inner product. 2 K2 CO3

17. Define self-adjoint operator. 2 K1 CO4

18. Define minimal solution. 2 K1 CO4

19. Determine the complete integral of the partial differential equation $p^2 + q^2 = 1$. 2 K2 CO5

20. Determine the complete integral of the equation $pq = y$. 2 K2 CO5

21. Solve $(D^3 + D^2D' - DD'^2 - D'^3)z = 0$. 2 K2 CO6

22. Solve $(D + D' - 1)(D - 2D' + 3)z = 0$. 2 K2 CO6

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23. a) Let $S = \{(2,-3,5),(8,-12,20),(1,0,-2),(0,2,-1),(7,2,0)\}$ generates R^3. Find a basis for R^3 that is a subset of S. 11 K3 CO1

OR

b) Show that $S = \{(1,3,-4,2),(2,2,-4,0),(1,-3,2,-4),(-1,0,1,0)\}$ in R^4 is linearly dependent. 11 K3 CO1

24. a) Let $T: R^2 \to R^3$ be defined by $T(x,y) = (2x - y, 3x + 4y, x)$, analyze the transformation and 11 K4 CO2

(i) Determine the matrix representation of the transformation T with respect to the standard basis of R^2 and R^3.

(ii) Examine the null space of T and state its dimension. From the null space infer whether T is one to one or not.

(iii) Identify the range space of T, compute its dimension Check whether T is onto or not?

OR

b) Let $T: R^2 \to R^3$ be a linear transformation such that $T(1,1) = (1,0,2)$ and $T(2,3) = (1,-1,4)$, analyze the given transformation and 11 K4 CO2

(i) Determine the general form of $T(x,y)$.

(ii) Compute $T(2,5)$and $T(8,11)$.

(iii) Analyze the image of T and determine its rank.

25. a) Find an orthonormal basis of the inner product space $R^3(R)$ with standard inner product, given the basis $B = \{(1,1,0),(1,-1,1),(-1,1,2)\}$ using Gram-Schmidt orthogonalization process. 11 K3 CO3

OR

b) Determine the QR-decomposition of $A = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix}$. 11 K3 CO3

26. a) For each of the following inner product space V and linear operator T on V, evaluate T^*at the given vector in V. 11 K3 CO4

(a) $V = R^2, T(a,b) = (2a + b, a - 3b), x = (3,5)$

(b) $V = C^2, T(z_1,z_2) = (2z_1 + iz_2, (1-i)z_1), x = (3 - i, 1 + 2i)$

OR

b) Find the least square solution of $AX = b$,where 11 K3 CO4

$A = \begin{bmatrix} 1 & 2 & -1 \\ 2 & 3 & 1 \\ 4 & 7 & -1 \end{bmatrix}, b = \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix}$. Also find the least square error.

27. a) Classify the partial differential equation $(3z-4y)p+(4x-2z)q=2y-3x$ and solve it. *11 K4 CO5*

OR

b) (i) Classify the type of the partial differential equation $p-y^2=q+x^2$ and solve it. *5 K4 CO5*

(ii) Derive the singular integral for the partial differential equation. $z=px+qy+p^2+pq+q^2$, *6 K4 CO5*

28. a) Solve the following equation. $(D^2+DD'-6D'^2)z=e^{3x+y}+x^2y$. *11 K3 CO6*

OR

b) Solve: $(D^2+2DD'+D'^2-2D-2D')z=\sin(x+2y)$. *11 K3 CO6*