

Q.P Code: D143773	Total Pages:3	Name	737195
		Register No.	
FOURTH SEMESTER (CUFYUGP) DEGREE EXAMINATION, APRIL 2026			
MATHEMATICS			
MAT4CJ204 Basic Linear Algebra			
2024 Admission Onwards			
Maximum Time: 2 Hours		Maximum Marks :70	

Section A

All Question can be answered. Each Question carries 3 marks (Ceiling: 24 Marks)

1	Define a subspace. Is the set $\{0\}$ a subspace of any vector space V ?
2	Verify whether the set $W = \{\mathbf{v} = (x, y, z) \in \mathbb{R}^3 : x + y + z = 0\}$ is a subspace of \mathbb{R}^3 .
3	Find the coordinate vector $[x]_{\mathcal{B}}$ of x relative to the given basis $\mathcal{B} = \{b_1, \dots, b_n\}$, where $b_1 = \begin{bmatrix} 1 \\ -3 \end{bmatrix}$, $b_2 = \begin{bmatrix} 2 \\ -5 \end{bmatrix}$, $x = \begin{bmatrix} -2 \\ 1 \end{bmatrix}$
4	Find a basis for the subspace of \mathbb{R}^3 $H = \{(a, b, c) : a = 2b\}$.
5	Explain the concept of orthogonal projection.
6	Define an orthonormal set. Determine whether the vectors $u = (1, 2, -1)$, $v = (2, -1, 0)$ are orthogonal.
7	Verify the Pythagorean theorem for vectors $u = (1, 1, 0)$, $v = (1, -1, 0)$.
8	Determine whether the matrix $A = \begin{bmatrix} 2 & 3 \\ 3 & 5 \end{bmatrix}$ is orthogonally diagonalizable.
9	True or False: "An nn matrix that is orthogonally diagonalizable must be symmetric." . Justify your answer
10	Explain different types of quadratic forms with proper examples

Section B

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All Question can be answered. Each Question carries 6 marks (Ceiling: 36 Marks)

11	Given \mathbf{v}_1 and \mathbf{v}_2 in a vector space V , let $H = \text{Span}\{\mathbf{v}_1, \mathbf{v}_2\}$. Show that H is a subspace of V .
12	Let W be the set of all vectors of the form $\begin{bmatrix} s + 3t \\ s - t \\ 2s - t \\ 4t \end{bmatrix}$ Show that W is a subspace of \mathbb{R}^4 with dimension 2.
13	Find bases for the row space, the column space, and the null space of the matrix $\begin{bmatrix} 1 & 2 & 4 & -1 \\ 3 & 2 & 0 & 9 \\ -3 & 4 & 1 & 0 \end{bmatrix}$
14	Let \mathcal{B} be the basis of \mathbb{P}_3 consisting of the Hermite polynomials $\mathcal{B} = \{1, 2t, 4t^2 - 2, 8t^3 - 12t\}$. Let $p(t) = 7 - 12t - 8t^2 + 12t^3$. Find the coordinate vector of p relative to \mathcal{B} .
15	Suppose \mathbf{y} is orthogonal to \mathbf{u} and \mathbf{v} . Show that \mathbf{y} is orthogonal to every \mathbf{w} in $\text{Span}\{\mathbf{u}, \mathbf{v}\}$
16	Let $\mathbf{y} = \begin{bmatrix} 2 \\ 6 \end{bmatrix}$ and $\mathbf{u} = \begin{bmatrix} 7 \\ 1 \end{bmatrix}$. Write \mathbf{y} as the sum of a vector in $\text{Span}\{\mathbf{u}\}$ and a vector orthogonal to \mathbf{u} .
17	Let $A = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 3 & 1 \\ 1 & 1 & 3 \end{bmatrix}$ and $v = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$. Verify that 2 is an eigenvalue of A and v is an eigenvector. Then orthogonally diagonalize A .
18	Classify the quadratic form $9x_1^2 - 8x_1x_2 + 3x_2^2$

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Section C

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Answer any ONE. Each Question carries 10 marks (1x10=10 Marks)

19	<p>Let $\mathbf{v}_1 = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}$, $\mathbf{v}_2 = \begin{bmatrix} 2 \\ 1 \\ 3 \end{bmatrix}$, $\mathbf{v}_3 = \begin{bmatrix} 4 \\ 2 \\ 6 \end{bmatrix}$, and $\mathbf{w} = \begin{bmatrix} 3 \\ 1 \\ 2 \end{bmatrix}$.</p> <p>(a) Is \mathbf{w} in $\{\mathbf{v}_1, \mathbf{v}_2, \mathbf{v}_3\}$? How many vectors are in $\{\mathbf{v}_1, \mathbf{v}_2, \mathbf{v}_3\}$?</p> <p>(b) How many vectors are in $\text{Span}\{\mathbf{v}_1, \mathbf{v}_2, \mathbf{v}_3\}$?</p> <p>(c) Is \mathbf{w} in the subspace spanned by $\{\mathbf{v}_1, \mathbf{v}_2, \mathbf{v}_3\}$? Why?</p>
20	<p>Find a QR factorization of the matrix</p> $\begin{bmatrix} 1 & 2 & 5 \\ -1 & 1 & -4 \\ -1 & 4 & -3 \\ 1 & -4 & 7 \\ 1 & 2 & 1 \end{bmatrix}$