Register Number:……………..

KUMARAGURU college of technology

character is life

B.E/B.TECH DEGREE EXAMINATIONS: NOV /DEC 2024

(Regulation 2024)

First Semester

COMMON TO CSE / IT/ AI&DS

24MAI114: Applied Linear Algebra and Calculus

COURSE OUTCOMES

CO1: Apply the concepts of eigenvalues and eigenvectors to diagonalize matrices and solve systems of linear equations in real-world applications.

CO2: Apply the concepts of vector spaces, subspaces, and matrix decomposition techniques such as LU decomposition and Singular Value Decomposition to solve linear systems and reduce matrix complexity in data science and engineering problems.

CO3: Apply differentiation techniques to solve optimization problems including finding maxima and minima and use integration methods to compute arc lengths, areas between curves, and volumes of solids for practical engineering and computational applications.

CO4: Apply multivariate calculus concepts such as partial derivatives and Taylor's series expansion to analyze and approximate multivariable functions for solving engineering and computational problems.

CO5: Analyze and solve unconstrained and constrained optimization problems using the Lagrange multiplier method and determine the maxima and minima of functions with two or more variables relevant to machine learning and data science applications.

CO6: Analyze methods for solving first-order and higher-order ordinary differential equations to model and analyze dynamic systems in engineering and computing, using appropriate solution techniques to address real-world problems.

Time: Three Hours **Maximum Marks: 100**

PART A (4*20 = 80 Marks)
Answer all the Questions

1.	a)	State the Cayley-Hamilton theorem with an example.	2	CO1	[K_2]
	b)	A matrix B is given as $\begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$. Determine its eigenvalues and eigenvectors.	8	CO1	[K_3]

10 CO1 [K_3]

c) Scenario: In a computer graphics application, work has been done on a data compression algorithm. The matrix $\begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$ represents the relation between three important features in image data. Diagonalize it using orthogonal transformation.

2. a) Define maxima and minima in the context of differentiation. 2 CO3 [K_1]

b) Find the maxima of the function $f(x) = -2x^2 + 4x + 1$. 4 CO3 [K_3]

c) Compute the area between $y = x^2$ and $y = 2x + 3$ in the interval $x = -1$ and $x = 3$ along x axis 8 CO3 [K_3]

d) Evaluate the volume of a solid obtained by rotating $y = x^2$ about the x-axis over the interval [0, 2]. 6 CO3 [K_3]

3. a) Solve the ordinary differential equation $\frac{dy}{dx} + y = e^x$. 2 CO6 [K_3]

b) Solve the second-order homogeneous ordinary differential equation $y'' - 3y' + 2y = e^{3x}$. 8 CO6 [K_3]

c) Using Leibnitz theorem, approximate the solution of $y' = x + y$ at $x = 0.1$ with $y(0) = 1$. 6 CO6 [K_3]

d) Explain the applications of higher order ordinary differential equations by providing an example. 4 CO6 [K_2]

4. a) State Euler's theorem for homogeneous functions. 2 CO4 [K_2]

b) Approximate the function $f(x, y) = x^2 + y^2 + xy$ near (1,1) using Taylor's series. 8 CO4 [K_3]

c) Solve $\mathrm{f(x, y) = x^2 + y^2 + z^2}$ subject to $xyz = a^3$. 8 CO5 [K_3]

d) Give the applications of maxima and minima relevant to machine learning and data science applications. 2 CO5 [K_2]

PART B (1 x 20 = 20 Marks)
Answer any ONE Question

5.	a)	Define a vector space with an example.	2	CO2	[K_1]
	b)	Perform LU decomposition of $A = \begin{bmatrix} 1 & 3 & 6 \\ 2 & 8 & 16 \\ 5 & 21 & 45 \end{bmatrix}$.	8	CO2	[K_2]
	c)	Apply SVD on $A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 1 & 3 \end{bmatrix}$	10	CO2	[K_3]

OR

6.	a)	How do we define the concept of linear independence?	2	CO2	[K_1]
	b)	Illustrate the concept of subspaces with an example.	2	CO2	[K_2]
	c)	Perform LU decomposition of $A = \begin{bmatrix} 8 & 2 & 9 \\ 4 & 9 & 4 \\ 6 & 7 & 9 \end{bmatrix}$.	12	CO2	[K_3]
	d)	Identify the linearly independent vectors in the set $(1,-1,1), (0,1,2), (3,0,-1)$.	4	CO2	[K_3]

CO distribution summary

	CO1	CO2	CO3	CO4	CO5	CO6
Marks (%)	20	20	20	10	10	20

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