Register Number:……………..

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

(Regulation 2024)

First Semester

COMMON TO AERO / AUTO / CIVIL / MECH / MCE

24MAI111: Linear Algebra and Calculus

COURSE OUTCOMES

CO1: Apply eigenvalues for matrix diagonalization and transformations, and analyze results using computational tools.

CO2: Apply differentiation for solving optimization problems and enhance solutions through computational tools.

CO3: Apply partial differentiation for constrained optimization and evaluate with numerical techniques.

CO4: Apply integral calculus and computational tools to solve engineering problems.

CO5: Apply double integrals and computational tools for solving engineering problems.

CO6: Apply triple integrals techniques and computational tools to solve complex problems.

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

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

1.	a)	Define a real symmetric matrix and its importance in diagonalization.	2	CO1	[K_1]
	b)	State any two properties of eigenvalues.	2	CO1	[K_1]
	c)	Scenario: In a mechanical engineering application, a quadratic form $Q = 5x^2 + 8xy + 5y^2$ is used to analyze the stress on a material. Diagonalize this quadratic form to determine its principal axes.	8	CO1	[K_3]
	d)	Find the eigenvalues and eigenvectors of the matrix $A = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$.	6	CO1	[K_3]
	e)	What role do eigenvalues play in an orthogonal transformation? Give an example.	2	CO1	[K_2]
2.	a)	What is the total derivative? Provide an example.	2	CO3	[K_2]
	b)	State the significance of Jacobians in transformations.	2	CO3	[K_1]
	c)	Use Taylor's series to approximate $f(x, y) = log(1 + x + y)$ near (0,0) up to second order derivatives.	6	CO3	[K_3]
	d)	Find the stationary points of $f(x, y) = x^2 + y^2 - 4x - 6y$ and classify them using Lagrange's multiplier method with the constraint $x + y = 4$.	6	CO3	[K_3]
	e)	Find the Jacobian of the transformation $u = x^2 + y, v = x - y^2$.	4	CO3	[K_3]
3.	a)	Define integration by substitution and give an example	2	CO4	[K_1]

	b)	Evaluate $\int \frac{x^2}{(x^2+1)} dx$ using substitution.	2	CO4	[K_3]
	c)	Solve $\int_0^{\pi} x^2 \cos x \, dx$ using integration by parts.	6	CO4	[K_3]
	d)	Evaluate $\int \frac{dx}{(x+4)(x+3)(x+1)}$ using partial fraction method.	6	CO4	[K_3]
4.	a)	Define double integration and its application in finding area.	2	CO5	[K_3]
	b)	Solve the double integral $\int_0^2 \int_0^x (x+y) \, dy \, dx$.	2	CO5	[K_3]
	c)	Evaluate the double integral $\int_0^1 \int_0^{1-x} (x+y) \, dy \, dx$.	8	CO5	[K_3]
	d)	Find the volume of ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$	8	CO6	[K_3]

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

5.	a)	State Rolle's theorem.	2	CO2	[K_1]
	b)	Verify Rolle's theorem for $f(x) = x^2 - 4x + 4$ in the interval [2,4].	2	CO2	[K_3]
	c)	Find the local maxima and minima of $f(x) = x^3 - 6x^2 + 9x + 2$.	6	CO2	[K_3]
	d)	Using differentiation, determine the points of inflection for $f(x) = x^4 - 4x^3 + 6x^2$.	6	CO2	[K_3]
	e)	Prove that the derivative of $f(x) = \sin(x) \cdot e^x$ is $f'(x) = e^x(\sin x + \cos x)$	4	CO2	[K_1]

OR

6.	a)	Define Mean Value Theorem and state its significance.	2	CO2	[K_1]
	b)	Verify the Mean Value Theorem for $f(x) = x^2 + 3x$ on the interval [0,2].	2	CO2	[K_2]
	c)	Find the maximum and minimum values of $f(x) = 2x^3 - 9x^2 - 24x - 20$	8	CO2	[K_3]
	d)	Give the significance of optimization problems using a real-world example.	2	CO2	[K_3]
	e)	Verify Rolle's theorem for $f(x) = 2x^3 - 5x^2 - 4x + 3$ in the interval $[\frac{1}{2}, 3]$.	6	CO2	[K_3]

CO distribution summary:

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

****