A **Reg. No. :** | | | | | | | | | | | | |

Question Paper Code: R1M02

B.E./B.Tech. DEGREE EXAMINATION, DEC 2025

First Semester

Common to all Departments expect CSBS Branch

R21UMA102- MATRIX & CALCULUS

(Regulations R2021)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The Index of the matrix A is the number of ______ Eigen values of A CO6-U

(a) zero (b) non zero (c) negative (d) positive

2. The rank of the matrix A is the number of ______ Eigen values of A CO6-U

(a) zero (b) non zero (c) negative (d) positive

3. $\underset{\theta \to 0}{lt} \frac{\sin \theta}{\theta} =$ ____ CO6-U

(a) θ (b) 2 (c) 1 (d) 0

4. The value of $\underset{n \to \infty}{lt} \frac{10n^2 + 8}{2n^2 + 5}$ CO6-U

(a) 5 (b) 8/5 (c) 1 (d) 0

5. If $AC-B^2>0$ and $A<0$, then f(a,b) has a ________ value. CO6-U

(a) minimum (b) maximum (c) not extremum (d) inconclusive

6. If u, v, w are functionally dependent functions of independent variables x, y, z CO6-U

then $\frac{\partial(u, v, w)}{\partial(x, y, z)} =$ _____

(a) $\frac{\partial(x, y, z)}{\partial(u, v, w)}$ (b) 0 (c) 1 (d) -1

7. The value of $\Gamma(\frac{1}{2}) =$ ______ CO6-U

(a) π (b) $\frac{\pi}{2}$ (c) $\frac{\sqrt{\pi}}{2}$ (d) $\sqrt{\pi}$

8. $\beta(p,q)$ is equal to CO6-U

(a) $\frac{\lceil p \lceil q}{\lceil pq}$ (b) $\frac{\Gamma(p)\Gamma(q)}{\Gamma(p+q)}$ (c) $\frac{\lceil p}{\lceil p+q}$ (d) $\frac{\lceil q}{\lceil p+q}$

9. If x = r cosθ, y = r sinθ then dxdy = ____ CO6-U

(a) r dr dθ (b) dr dθ (c) r^2 dr dθ (d) $\frac{1}{r}$ dr dθ

10. The region of integration of the integral CO6-U

$\int_0^1 \int_0^x f(x,y)\,dxdy$ is

(a) square (b) rectangle (c) triangle (d) circle

PART – B (5 x 2= 10 Marks)

11. Two Eigen values of $A = \begin{bmatrix} 4 & 6 & 6 \\ 1 & 3 & 2 \\ -1 & -5 & -2 \end{bmatrix}$ are equal and they are double the third, Apply the properties of Eigen values to find the Eigen values of A^2. CO1-App

12. Find n^{th} derivative of $\log(3x+5)$. CO2-App

13. Compute the Jacobian of x, y with respect to r, θ if $x = 2r\cos\theta, y = 3\sin\theta$. CO3-App

14. Apply the concept of Gaussian integrals to Compute the value of CO4-App

$\int_0^\infty x^7 e^{-x}\,dx$.

15. Apply the concept of triple integration to evaluate $\int_1^3 \int_1^2 \int_1^5 \frac{dxdydz}{xyz}$. CO5-App

PART – C (5 x 16= 80 Marks)

16. (a) (i) Apply the Cayley-Hamilton theorem to find CO1-App (8)

A^{-1} and A^4 for $A = \begin{bmatrix} 2 & -1 & 2 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$.

		(ii) Apply the Characteristic equation method to find the Eigen values and Eigen Vectors of the matrix $\begin{bmatrix} 5 & 0 & 1 \\ 0 & -2 & 0 \\ 1 & 0 & 5 \end{bmatrix}$.	CO1-App	(8)
		Or		
	(b)	Apply the concept of quadratic forms and orthogonal transformations, reduce the quadratic form $6x^2 + 3y^2 + 3z^2 - 4xy - 2yz + 4xz$ to its canonical form, and determine its rank, signature, index, and nature .	CO1-App	(16)
17.	(a)	(i) Analyze the behavior of n^{th} derivative to Compute $\frac{2x-3}{x^2-3x+2}$.	CO2-Ana	(8)
		(ii) Analyze the relationship between half-life, decay constant, and remaining mass to determine the mass of an Iodine isotope after 30 days, given its half-life is 8 days and the initial mass is 200 g.	CO2-Ana	(8)
		Or		
	(b)	(i) Using the coffee-cooling scenario (190°F → 160°F in 5 min, room temp = 70°F), analyze how changes in the cooling constant would influence the time required for the coffee to reach 130°F.	CO2-Ana	(8)
		(ii) Expand $e^{\cos x}$ by using Maclaurin's series, up to the term containing x^4.	CO2-Ana	(8)
18.	(a)	(i) Find the greatest and the least distances of the point(3,4,12) from the unit sphere whose Centre is at the origin .	CO3-App	(8)
		(ii) If $x = r\sin\theta\cos\phi$, $y = r\sin\theta\sin\phi$, $z = r\cos\theta$ then find $\frac{\partial(x,y,z)}{\partial(r,\theta,\phi)}$.	CO3-App	(8)
		Or		
	(b)	(i) Using Taylor's series expand $e^x \cos y$ about $\left(0, \frac{\pi}{2}\right)$ up to third degree terms.	CO3-App	(8)
		(ii) Apply the partial differentiation to compute the extreme values of the function $f(x,y) = x^3 + y^3 - 3x - 12y + 50$.	CO3-App	(8)

19.	(a)	(i) Apply the reduction concept to derive reduction formula for $\int \sin^n x \, dx$	CO4- App	(10)
		(ii) Apply the concept of definite integrals to evaluate $\int_0^\infty \frac{x^c}{c^x} dx$.	CO4- App	(6)
		Or		
	(b)	(i) Apply the Beta and Gamma functions, , Show that $\beta(a,b) = \frac{\Gamma(a)\Gamma(b)}{\Gamma(a+b)}$.	CO4- App	(10)
		(ii) Apply the concept of definite integrals to evaluate $\int_0^{\frac{\pi}{2}} \frac{(\sin x)^{\frac{3}{2}}}{(\cos x)^{\frac{3}{2}} + (\sin x)^{\frac{3}{2}}} dx$.	CO4- App	(6)
20.	(a)	(i) Apply the Triple integration to compute the volume of the Sphere $\mathbf{x^2 + y^2 + z^2 = a^2}$.	CO5-App	(8)
		(ii) Apply the rule of double integration to Change the order of integration in $\int_0^{4\mathbf{a}} \int_{\frac{\mathbf{x}^2}{4\mathbf{a}}}^{2\sqrt{\mathbf{ax}}} \mathbf{xy\,dy\,dx}$.	CO5-App	(8)
		Or		
	(b)	(i) By transforming into polar coordinates and hence evaluate $\iint \frac{x^2 y^2}{x^2 + y^2} dx dy$ over the annular region $x^2 + y^2 = a^2$ & $x^2 + y^2 = b^2$ $(b > a)$.	CO5-App	(8)
		(ii) Apply the double integral, compute the area of the circle $x^2 + \mathbf{y}^2 = a^2$.	CO5-App	(8)