Reg. No. : | | | | | | | | | | | | |

Question Paper Code: R3M23S

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

Third Semester

Electronics and Communication Engineering

R21UMA323 – NUMERICAL ANALYSIS AND LINEAR ALGEBRA

(Regulations R2021)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. Truncation error in Trapezoidal rule is of the order ___. CO1- U

   (a) h^3 (b) h^2 (c) h^4 (d) 0

2. The restriction on the number of intervals in Simpson's one third rule is ____ CO1- U

   (a) odd (b) even (c) equal (d) unequal

3. In Euler's method, if h is small, the method is too _______ CO2- U

   (a) fast (b) slow (c) average (d) None of these

4. The Runge-Kutta method of second order is nothing but the ___________ CO2- U

   (a) Euler's method (b) modified Euler's method

   (c) improved Euler's method (d) Taylor's series method

5. PDE of second order, if B^2-4AC> 0 then CO3- U

   (a) parabolic (b) elliptic (c) Hyperbolic (d) None of the above

6. $u_{xx} + u_{yy} = 0$ is a __________ equation CO3- U

   (a) Laplace (b) Poisson (c) Binomial (d) None of the above

7. The trivial subspaces of a vector space V are __________ CO4- U

   (a) {0} (b) V (c) W (d) {0}and V

8. If T: V→W be linear transformation then T(0) = __________ CO4- U

   (a) 0 (b) 1 (c) 2 (d) 3

9. In a vector sapace V , for $x, y, z \in V$ if $\langle x, y\rangle = \langle y, z\rangle$ then ________ CO5- U

(a) $y = z$ (b) $y \neq z$ (c) $y = -z$ (d) none of these

10. The norm of $(3, -4, 0)$ is ________ CO5- App

(a) 3 (b) -4 (c) 0 (d) 5

PART – B (5 x 2= 10 Marks)

11. State Newton's backward interpolation formula to compute first two derivatives of y at $x = x_n$ CO1- U

12. Using Taylor's series method find y(0.1) given $y' = 1 + y$ with y(0) = 1 CO2 -App

13. What is the purpose of Liebmann iteration process? CO3 U

14. Prove that W={(a,0,0) / a $\in$ R} is a subspace of R^3 CO4-App

15. Find the norm of $(1, 2, 3)$ in $V_3(R)$ with standard inner product. CO5 -App

PART – C (5 x 16= 80Marks)

16. (a) (i) Compute CO1- App (8)

$\frac{dy}{dx}, \frac{d^2y}{dx^2}$ at x=1.5 from the following data

x	1.5	2.0	2.5	3.0	3.5	4.0
y	3.375	7.000	13.625	24.000	38.875	59.000

(ii) Evaluate $\int_0^{\pi} \sin x\, dx$ by dividing the range into 10 equal parts CO1- App (8)

using

(a) Trapezoidal rule

(b) Simpson's $\frac{1}{3}$ rule.

Or

(b) (i) Evaluate CO1- App (8)

$\int_0^1 \frac{dx}{1 + x^2}$ using Romberg's method correct to 4 decimal places.

(ii) Evaluate CO1-App (8)

$\int_0^1 \frac{1}{1 + x^2} dx$ using two point Gaussian quadrature formula

17. (a) (i) Using Taylor's series method find y(0.1) for $\frac{dy}{dx} = x^2 y - 1$, y(0) = 1 — CO2-App (8)

(ii) Using Euler's method find y(0.2) and y(0.4) from $\frac{dy}{dx} = x + y$, y(0) = 1 — CO2- App (8)

Or

(b) (i) Using R-K method of fourth order, solve $\frac{dy}{dx} = y - x^2$ with y(0) = 1 at x = 0.2 — CO2- App (8)

(ii) Using Milne's method find y(4.4) given $5xy' + y^2 - 2 = 0$ given
y (4) = 1, y(4.1) = 1.0049, y(4.2)= 1.0097 and y(4.3)= 1.0143 — CO2- App (8)

18. (a) (i)Solve $\frac{\partial^2 u}{\partial x^2} = 32\frac{\partial u}{\partial t}$, u(0,t) = 0 , u(1,t) = t , u(x,0) = 0 . Take h = 0.25 and find the values of u up to t = 5 using Bender-Schmidt's difference equation. — CO3- App (8)

(ii) Using Crank-Nicholson's difference equation to solve $\frac{\partial^2 u}{\partial x^2} = \frac{\partial u}{\partial t}$ u(0,t) = 0 , u(1,t) = t , u(x,0) = 0. compute u for one time step function with h=0.25 . — CO3- App (8)

Or

(b) Solve the Poisson equation $u_{xx} + u_{yy} = -81xy$, 0<x<1, 0<y<1 , u(0,y)=0, u(x,0) = 0, u(1,y)=100, u(x,1)=100 and h=1/3 — CO3- App (16)

19. (a) (i) Verify the vectors (1,2,0) , (2,3,0) ,(8,13,0) in R^3 is a basis of R^3 — CO4-App (8)

(ii) If $T : R^2 \rightarrow R^3$ be linear transformation defined by $T(a_1, a_2) = (a_1 + a_2, 0, 2a_1 - a_2)$ then find nullity(T) ,rank(T), Is T one-to-one? Is T onto? Also check the rank nullity theorem. — CO4- App (8)

Or

(b) (i) Find the dimension of the subspace spanned by the vectors (2,0,1) ,(-1,0,1) ,(1,0,2) in $V_3(R)$. CO4- App (8)

(ii) Find the matrix of the linear transformation $T : V_2(R) \rightarrow V_3(R)$ defined by $T(a,b) = (a - b, 2a, 3a + 2b)$ for the standard basis of $V_2(R)$. CO4- App (8)

20. (a) (i) Show that the following function defines an inner product on $V_2(R)$ where $x = (x_1, x_2)$ and $y = (y_1, y_2)$ and $\langle x, y \rangle = x_1 y_1 + 2 x_2 y_2$. CO5- App (8)

(ii) If $x = (1 + i, 2, i)$ and $y = (3i, 2 + 3i, 4)$ then verify Schwarz's inequality. CO5- App (8)

Or

(b) (ii) Apply Gram-Schmidt process to construct an orthonormal basis for $V_3(R)$ with the standard inner product for the basis $\{v_1, v_2, v_3\}$ where $v_1 = (1,0,1)$, $v_2 = (1,3,1)$ and $v_3 = (3,2,1)$ CO5- App (16)