



QP CODE: 23144686



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Reg No : .....

Name : .....

**M Sc DEGREE (CSS) EXAMINATION, NOVEMBER 2023**

**Third Semester**

Faculty of Science

**CORE - PH010302 - COMPUTATIONAL PHYSICS**

M Sc PHYSICS, M Sc SPACE SCIENCE

2019 ADMISSION ONWARDS

2102C83C

Time: 3 Hours

Weightage: 30

**Part A (Short Answer Questions)**

Answer any **eight** questions.

Weight **1** each.

1. Explain what is meant by residual? What is the significance of the sum of squares of residuals while fitting a curve?
2. Explain the procedure for fitting a curve of the form  $y = ax^b$  using the method least squares.
3. Using Newtons forward interpolation formula find the cubic polynomial which takes the following values

x	0	1	2	3
y	1	2	1	10

4. Write the algorithm to find the integral of a function using Simpson's 1/3 rule?
5. Compare the error in Trapezoidal and Simpson's rules for numerical integration.
6. How do we use Runge Kutta method to solve a system of equations.
7. Solve the following system of equations using Gauss – Jordan method.  
 $x + y = 5$   
 $2x + 2y = 10$
8. Briefly explain the theory of Jacobi's method to obtain eigen values and eigen vectors of a real symmetric matrix
9. Explain the term discretization with respect to parabolic partial differential equation





10. Discuss the requirements for random number generation

(8×1=8 weightage)

### Part B (Short Essay/Problems)

Answer any **six** questions.

Weight 2 each.

11. Fit a second-order polynomial into the data

X	0	0.5	1	1.5	2	2.5
y	1	1.25	2	3.25	5	7.25

12. Show that the  $n^{\text{th}}$  difference of an  $n^{\text{th}}$  degree polynomial is a constant and  $(n+1)^{\text{th}}$  difference is zero.

13. Find the first and second derivatives of the function tabulated below at the point  $x = 1.5$ .

x	1.5	2	2.5	3	3.5	4
y	3.375	7.0	13.625	24.0	38.875	59.0

14. A curve passes through the points (2,12), (3,45) and (4,112). Find  $\frac{dy}{dx}$  at  $x=2$  using cubic spline method.

15. Given  $y' = x + y$ , and  $y(0) = 1$ , find  $y(0.1)$  by Euler's method.

16. Find the inverse of the matrix  $\begin{bmatrix} 1 & 1 & 2 \\ 1 & 2 & 4 \\ 2 & 4 & 7 \end{bmatrix}$  using by Gauss Jordan method.

17. Solve the diffusion equation using Crank – Nicolson method:  $T_t = T_{xx}$ ,  $0 \leq x \leq 1$ , subjected to the initial condition  $T(x, 0) = 0$  and the boundary conditions  $T(0, t) = 0$  and  $T(1, t) = t$  for  $t > 0$  after one –time step, by choosing  $\Delta x = \frac{1}{4}$ ,  $\Delta t = \frac{1}{8}$ .

18. Write a brief note on how to evaluate integrals using Monte Carlo method

(6×2=12 weightage)

### Part C (Essay Type Questions)

Answer any **two** questions.

Weight 5 each.

19. Explain Cubic Spline Interpolation. The following value of  $x$  and  $y$  are given. Fit a natural cubic spline and evaluate  $y(1.5)$





x	1	2	3	4
y	1	2	5	11

20. Derive the general formula for numerical integration and arrive at simpsons 3/8 rule for Numerical integration. Also write the algorithm for this method
21. Using fourth order Runge – Kutta method find the solution of initial value problem  $y' = \frac{1}{x+y}$ ,  $y(0) = 1$  in the range  $0.5 \leq x \leq 2.0$ , by taking  $h = 0.5$ .
22. Use the explicit formula to solve the equation  $U_t = U_{xx}$  with the conditions  $U(0, t) = U(5, t) = 0$  and  $U(x, 0) = x(5 - x)$ . With  $h = 1$  and  $\Delta t = 0.5$ , tabulate the values of  $U_i^k$  for  $i = 0, 1, 2, 3, 4, 5$  and  $k = 0, 1$ .

(2×5=10 weightage)

