

Reg. No. :

Code No. : 5451

Sub. Code : WPHM 33

M.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2025.

Third Semester

Physics – Core

NUMERICAL METHODS AND PROGRAMMING
IN C++

(For those who joined in July 2023 onwards)

Time : Three hours

Maximum : 75 marks

PART A — ($15 \times 1 = 15$ marks)

Answer ALL questions.

Choose the correct answer :

1. In a system of equations represented by an augmented matrix, the augmented part includes
 - (a) Only the coefficients of the variables
 - (b) The constants from the right-hand side of the equations
 - (c) Both the coefficients and the constants
 - (d) Only the dependent variables

2. The Gauss elimination method can also be applied to
- (a) Nonlinear systems
 - (b) Differential equations
 - (c) Matrix inversion
 - (d) Finding determinants
3. The convergence of the Newton-Raphson method is
- (a) Linear
 - (b) Quadratic
 - (c) Exponential
 - (d) Logarithmic
4. In the case of polynomial curve fitting, the degree of the polynomial affects
- (a) The complexity of the model
 - (b) The amount of data needed
 - (c) The interpretation of results
 - (d) All of the above

5. The least squares method assumes that the errors are
- (a) Normally distributed
 - (b) Uniformly distributed
 - (c) Exponentially distributed
 - (d) Binomially distributed
6. Overfitting in the context of least squares curve fitting occurs when
- (a) The model is too simple
 - (b) The model is too complex and fits noise in the data
 - (c) The number of data points is very large
 - (d) The residuals are minimized perfectly
7. In the Monte Carlo method, the basic idea involves
- (a) Using deterministic algorithms to find solutions
 - (b) Generating random samples to estimate a quantity
 - (c) Solving equations analytically
 - (d) Using gradient descent for optimization

8. A disadvantage of the Monte Carlo method is that
- (a) It can only be applied to linear problems
 - (b) It requires complex mathematical formulations
 - (c) It may be computationally expensive for high accuracy
 - (d) It provides exact solutions
9. In the context of Monte Carlo methods, importance sampling is used to
- (a) Increase the computational cost
 - (b) Improve the efficiency of the estimation
 - (c) Simplify the random variable
 - (d) Eliminate the need for random sampling
10. To improve the accuracy of the Euler method, one can
- (a) Decrease the step size
 - (b) Increase the step size
 - (c) Use a higher-order method
 - (d) Both (a) and (c)

11. The Euler method is best suited for
- (a) Stiff differential equations
 - (b) Linear and simple nonlinear equations
 - (c) Complex partial differential equations
 - (d) Systems with rapidly changing solutions
12. In practice, the Euler method is often used as
- (a) A final solution method
 - (b) A basis for more advanced methods
 - (c) A way to analyze non-differentiable functions
 - (d) A method only for academic purposes
13. If you want to use a structure as a parameter in a function, what is the default passing mechanism?
- (a) Pass by reference
 - (b) Pass by value
 - (c) It cannot be passed
 - (d) Pass by pointer

14. Can you use structure to create a data type that behaves like a class in C++?
- No, structure and class are completely different
 - Yes, but only if all members are public
 - Yes, structures can have private members too
 - Yes, but structure cannot have member functions
15. To read a file line by line in C++, which class would you typically use?
- ifstream
 - fstream
 - ifstream with getline()
 - Both (a) and (c)

PART B — (5 × 4 = 20 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Assuming that a root of $x^3 - 9x + 1 = 0$ lies in the interval (2,4) find that root by bisection method.
- Or
- (b) Using Newton's-Raphson method find the root between 0 and 1 of $x^3 = 6x - 4$ correct to 5 decimal places.

17. (a) Fit a straight line to the data given below. Also estimate the value of Y at $x = 2.5$.

x:	0	1	2	3	4
y:	1	1.8	3.3	4.5	6.3

Or

- (b) Using Lagrange's formula of interpolation find $y(10)$ from the following data

x:	5	6	9	11
y:	12	13	14	16

18. (a) Evaluate $I = \int_0^6 \frac{dx}{1+x}$ using Simpson's one-third rule.

Or

- (b) Using Jacobi method, find eigen value of

$$A = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

19. (a) Solve $\frac{dy}{dx} = x + y$, given $y(1) = 0$ and yet $y(1.1), y(1.2)$ by Taylor series method.

Or

- (b) Classify the following partial differential equations.

$$u_{xx} + 4u_{xy} + (x^2 + 4y^2)u_{yy} = \sin(x + y).$$

20. (a) Explain any two loop statements in C_{++} with examples.

Or

- (b) Write a C_{++} program to evaluate integral by Simpson's rule.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

21. (a) Solve the following system by Gauss seidal method.

$$10x - 5y - 2z = 3$$

$$4x - 10y + 3z = -3$$

$$x + 6y + 10z = -3$$

Or

- (b) Find by Gaussian elimination method inverse

$$\text{of } A = \begin{bmatrix} 3 & -1 & 1 \\ -15 & 6 & -5 \\ 5 & -2 & 2 \end{bmatrix}.$$

22. (a) Deduce the Gregorg Newton interpolation forward formula for equal intervals.

Or

- (b) From the following table find $f(x)$ and hence $f(6)$ using Newton's formula.

$$x: \quad 1 \quad 2 \quad 7 \quad 8$$

$$f(x) \quad 1 \quad 5 \quad 5 \quad 4$$

23. (a) Explain the truncation error in Trapezoidal rule.

Or

- (b) Using power method, find all eigen value of

$$A = \begin{bmatrix} 5 & 0 & 1 \\ 0 & -2 & 0 \\ 1 & 0 & 5 \end{bmatrix}.$$

24. (a) Using Runge-Kutta method of fourth, solve

$$\frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2} \text{ given } y(0)=1 \text{ at } x=0.2, 0.4.$$

Or

- (b) Solve $\nabla^2 u = 8x^2y^2$ for square mesh given $u=0$ on the 4 boundaries dividing the square into 16 sub-square of length one unit.

25. (a) Write a C++ program to find Cauchy's constant by least square method.

Or

- (b) Write a C++ program to find currents in Wheatstone's bridge by Gauss-elimination method.
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