Reg. No. : .....

Code No. : 7808 **Sub. Code : WPHM 33**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2024.

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 × 1 = 15 marks)

Answer ALL questions.

Choose the correct answer :

1. The main advantages of using Gauss elimination is :
   (a) It requires less computation time than matrix inversion
   (b) It can be applied to non linear equations
   (c) It gives a unique solution for all systems of equations
   (d) It simplifies complex numbers

2. The partial pivoting techniques in Gauss elimination is used to :

(a) Simplify the matrix

(b) Improve numerical stability

(c) Reduce computation time

(d) Identify redundant equations

3. The Newton-Raphson method is primarily used to :

(a) Solve systems of linear equations

(b) Find roots of nonlinear equations

(c) Calculate definite integrals

(d) Approximate solutions to differential equations

4. The methods of least squares is primarily used to :

(a) Maximize the sum of square of errors

(b) Minimize the sum of squares of residuals

(c) Fit polynomial equations

(d) Compute correlation coefficients

5. The residuals in the least squares method are defined as :

(a) The differences between the actual data points and the fitted values

(b) The differences between predicted values and the mean

(c) The average of the observed values

(d) The total variation in the data

6. The least squares method can be extends to :

(a) Nonlinear models only

(b) Polynomial models only

(c) Multiple linear regression

(d) Both (b) and (c)

7. The accuracy of the Monte Carlo method generally improves with :

(a) Increasing the number of random samples

(b) Decreasing the number of random samples

(c) Using more complex algorithms

(d) Reducing the computational time

8. The Monte Carlo method can be particularly useful in :

(a) Deterministic problems

(b) Problems with high dimensionality

(c) Linear regression analysis

(d) Numerical differentiation

9. A key concept in the Monte Carlo method is :

(a) Uniform distribution of sample points

(b) Normal distribution of sample points

(c) Random sampling

(d) Analytical integration

10. The Euler method is used for :

(a) Solving algebraic equations

(b) Numerical integration

(c) Solving ordinary differential equations

(d) Finding eigen values

11. The parameter h in the Euler method represents :

(a) The step size

(b) The total number of steps

(c) The initial condition

(d) The error tolerance

12. The Euler method is classified as :

(a) Implicit method

(b) Explicit method

(c) Adaptive method

(d) Runge-Kutta method

13. How do you access the members of a structure named student using a pointer to that structure?

(a) student –> name

(b) student.name

(c) (*student).name

(d) both (a) and (c)

14. Which of the following statements about structure is true?

(a) structure can only contain primitive data types

(b) structure can be nested

(c) structure cannot have constructors or destructors

(d) structure are passed by reference only

15. If you attempt to dereference a null pointer in C++, what is the most likely outcome?

(a) The program will compile successfully

(b) It will output "null"

(c) The program may crash or produce undefined behavior

(d) It will return 0

PART B — (5 × 4 = 20 marks)

Answer ALL questions, choosing either (a) or (b).
Each answer should not exceed 250 words.

16. (a) Solve for a positive root of $x^3 - 4x + 1 = 0$ by Regula Falsi method.

Or

(b) Using bisection method, find the negative root $x^3 - 4x + 9 = 0$ by bisection method.

17. (a) By the method of least – squares find the best fitting straight line to the data given below.

x	5	10	15	20	25
y	15	19	23	26	30

Or

(b) Using Lagrange's formula of interpolation find $y(9.5)$ given.

x	7	8	9	10
y	3	1	1	9

18. (a) Evaluate $\int_0^1 \frac{dx}{1+x^2}$ using Trapezoidal rule with $h = 0.2$.

Or

(b) Using Jacobi method, find eigen value of $A = \begin{bmatrix} 1 & 3 \\ 3 & 4 \end{bmatrix}$.

19. (a) Using Taylor series method, find $y(1.1)$ and $y(1.2)$ correct to four decimal places given $\frac{dy}{dx} = xy^{1/3}$ and $y(1) = 1$.

Or

(b) Classify the following partial differential equations.

(i) $(x+1)u_{xx} - 2(x+2)u_{xy} + (x+3)u_{yy} = 0$

(ii) $x f_{xx} + y f_{yy} = 0,\ x > 0,\ y > 0$.

20. (a) Explain any two control statement with examples.

Or

(b) Write a C++ program to find the solution of equation $x^3 - x - 1 = 0$ by Newton – Raphson method.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b)
Each answer should not exceed 600 words.

21. (a) By Gauss elimination, find the inverse of $A = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 2 & 0 \\ 3 & -1 & -4 \end{bmatrix}$.

Or

(b) Solve the following system of equations by using Gauss – Jacobi method

$8x - 3y + 2z = 20$
$4x + 11y - z = 33$
$6x + 3y + 12z = 35.$

22. (a) Explain the properties of divided differences.

Or

(b) The population of a certain town is given below. Find the rate of growth of the population in 1931, 1941, 1961, and 1971.

Year	x	1931	1941	1951	1961	1971
Population in thousands	y	40.62	60.80	79.95	103.56	132.65

23. (a) Explain the truncation error in Simpson's rule.

Or

(b) Find the dominant eigen value and the corresponding eigen vector of $A = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$.

24. (a) Apply the forth order Runge-Kutta method to find $y(0.2)$ given that $\frac{dy}{dx} = x + y$, $y(0) = 1$.

Or

(b) Solve $\nabla^2 u = 10\left(x^2 + y^2 + 10\right)$ over the square mesh with sides $x = 0$, $y = 0$, $x = 3$, $y = 3$ with $u = 0$ on the boundary and mesh length one unit.

25. (a) Explain the program structure and header files in C++.

Or

(b) Writ a C++ program for charging the discharging of a condenser by Euler's method.
