

**2025/FYUG/ODD/SEM/
MTMSEC-201T/070**

FYUG Odd Semester Exam., 2025

MATHEMATICS

(3rd Semester)

Course No. : MTMSEC-201T

(Numerical Methods)

Full Marks : 50

Pass Marks : 20

Time : 2 hours

The figures in the margin indicate full marks
for the questions

UNIT—I

Answer any three questions :

1×3=3

- (a) Define absolute and relative percentage error.
- (b) Evaluate : $\Delta^3 f(x)$ if $f(x) = x^2$.
- (c) Define shift operator and inverse shift operator.
- (d) Show that $\nabla = 1 - E^{-1}$

(Turn Over)

(2)

2. Answer any one question :

- (a) Write down the approximate value of $\pi/4$ correct to four significant figures and then find absolute error and relative error.
- (b) Prove that $(1 + \nabla)(1 - \nabla) = 1$.

3. Answer any one question :

- (a) (i) If $y = 4 \cos x - 6x$, find the relative percentage error in y for $x = 0$, if the error in x is 0.005.
- (ii) Construct a forward difference table for $f(x) = x^3 + 2x + 1$ taking $x = 1, 2, 3, 4$.

(b) Find a polynomial of degree three satisfying the following data. Hence find the value of $f(1.5)$:

x	1	2	3	4	5
y	4	13	34	73	136

UNIT—II

4. Answer any three questions :

- (a) What do you mean by interpolation?
- (b) If you are given a set of data points $(x_0, y_0), (x_1, y_1), (x_3, y_3)$ and you need to find the value of y for x that falls between x_0 and x_1 , which interpolation would you use, Newton's forward or Newton's backward interpolation?

(3)

(a) State Newton's backward interpolation formula.

(b) Identify the correct statement :

- (i) If the unequally spaced arguments are given only then Lagrange's interpolation is used.
- (ii) If the equally spaced arguments are given only then Lagrange's interpolation is used.
- (iii) Lagrange's interpolation can be used for both equally and unequally spaced arguments.

5. Answer any one question :

(a) Given the table :

x	1	2	3
$f(x)$	1	8	27

Find $f(1.5)$ by Newton's forward interpolation formula.

- (b) Using Lagrange's interpolation formula find a polynomial which passes through the points $(1, 0), (2, 3)$ and $(3, 8)$.

(Turn Over)

(4)

6. Answer any one question :

(a) The population of a town in a census is given in the following table. Estimate the population for the year 2019 :

Year	x	1985	1995	2005	2015	2025
Population (in thousands)	y	46	66	81	93	101

(b) Derive Lagrange's interpolation formula in the form :

$$f(x) = \sum_{r=0}^n \frac{\phi(x) f(x_r)}{(x - x_r) \phi'(x_r)}$$

$$\text{where } \phi(x) = (x - x_0)(x - x_1) \dots (x - x_n) \\ = \prod_{r=0}^n (x - x_r)$$

UNIT—III

7. Answer any three questions :

(a) Bisection method is based on _____ theorem.

(Fill in the blank)

(b) What is the rate of convergence of bisection method?

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(5)

(a) Write the geometrical significance of Regula falsi method.

(b) What is the necessary condition for the convergence of fixed point iteration method?

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Answer any one question :

(a) Write the advantage of using Newton-Raphson method over secant method.

(b) Find the approximate root of $xe^x = 1$ in $[0, 1]$ using two iterations of bisection method.

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Answer any one question :

(a) Find the approximate value of $\frac{1}{17}$ correct upto 6 decimal places with initial approximation 0.05.

(b) Use secant method for 5 iterations to estimate a root of the equation $x^2 - 4x - 10 = 0$ with initial estimates of $x_1 = 4, x_2 = 2$.

(Turn Over)

(6)

UNIT—IV

10. Answer any three questions :

(a) Write the expression for $f'(x)$ if $f(x)$ is given by

$$f(x) = f(x_0) + u \frac{\Delta f(x_0)}{1!} + u(u-1) \frac{\Delta^2 f(x_0)}{2!} + u(u-1)(u-2) \frac{\Delta^3 f(x_0)}{3!} + \dots$$

$$\text{where } u = \frac{x - x_0}{h}$$

(b) Write the general quadrature formula for numerical integration.

(c) Write Simpson's three-eighth rule for the approximation of $\int_a^b f(x) dx$.

(d) In Simpson's one-third rule, the number of entries required is _____ (odd/even).
(Choose the correct answer)

11. Answer any one question :

(a) Find $\frac{dy}{dx}$ at $x = 1$ for the function $y = f(x)$ given in the following table :

x :	1	2	3
y :	2.7	3.3	4.0

(b) Discuss the geometrical significance of Simpson's one-third rule.

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(Continued)

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(7)

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Answer any one question :

(a) Evaluate

$$\int_0^1 (4x - 3x^2) dx$$

taking 10 intervals, by Trapezoidal rule.

(b) Evaluate

$$\int_0^1 \frac{x dx}{1+x}$$

correct up to three places of decimal, taking six intervals, by Simpson's one-third rule.

UNIT—V

13. Answer any three questions :

1×3=3

- (a) State a sufficient condition for the convergence of Gauss-Jacobi method.
- (b) Define rank of a matrix.
- (c) Which method, Gauss-Jacobi or Gauss-Siedel method, converges faster?
- (d) What is pivoting?

14. Answer any one question :

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- (a) What is the condition for the consistency of linear system of equations $Ax = B$?
- (b) Write all the elementary row operations of matrices.

(Turn Over)

15. Answer any one question :

(a) Solve the system of equations :

$$4x_1 + x_2 + x_3 = 2$$

$$x_1 + 5x_2 + 2x_3 = -6$$

$$x_1 + 2x_2 + 3x_3 = -4$$

(b) Find the inverse of

$$\begin{pmatrix} 2 & 2 & 3 \\ 2 & 1 & 1 \\ 1 & 3 & 5 \end{pmatrix}$$

using Gauss-Jordan method.

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