

**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

1. 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 $\nabla = 1 - E^{-1}$

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(2)

2. Answer any *one* question : 2

(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 : 5

(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. 3

(ii) Construct a forward difference table for $f(x) = x^3 + 2x + 1$ taking $x = 1, 2, 3, 4$. 2

(b) Find a polynomial of degree three satisfying the following data. Hence find the value of $f(1.5)$: 5

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

UNIT—II

4. Answer any *three* questions : $1 \times 3 = 3$

(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?

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(3)

(c) State Newton's backward interpolation formula.

(d) 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 : 2

(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 $(3, 8)$.

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(4)

6. Answer any one question : 5

- (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	y	: 46	66	81	93	101
(in thousands)						

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

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

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

UNIT—III

7. Answer any three questions : 1×3=3

- (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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- (c) Write the geometrical significance of Regula falsi method.

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

8. Answer any one question : 2

- (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.

9. Answer any one question : 5

- (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 $x_1 = 4, x_2 = 2$.

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UNIT—IV

10. Answer any *three* questions : 1×3=3

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

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

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 : 2

- (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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12. Answer any *one* question : 5

- (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 : 2

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

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15. Answer any one question :

5

(a) Solve the system of equations :

$$\begin{aligned}4x_1 + x_2 + x_3 &= 2 \\x_1 + 5x_2 + 2x_3 &= -6 \\x_1 + 2x_2 + 3x_3 &= -4\end{aligned}$$

(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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