

# Numerical Methods

Course code: MAOE03

Course Credits :4:0:0

## ➤ Course Objectives:

The Student will Learn

1. The concept of different types of errors.
2. To obtain roots of algebraic and transcendental equations.
3. The concept of interpolation, differentiation and integration of a tabulated function.
4. The technique of solving simultaneous and second order ODE's
5. To solve system of linear algebraic equations and to find eigenvalues and eigenvectors of a given square matrix.
6. The stability of Numerical method applied to PDE's and some techniques to solve Elliptic, Parabolic and Hyperbolic equations.

## ➤ Course contents:

### Unit-1

**Errors, Numerical solution of Algebraic and Transcendental equations:** Different types of errors, Fixed point iteration method, Aitken's  $\Delta^2$  process method, Newton - Raphson method for a system of two simultaneous equations, Horner's method, Grafee's root squaring method, Birge Vietta method.

### Unit-II

**Interpolation:** Hermite and cubic spline interpolation, Bivariate interpolation-Lagrange's bivariate interpolation, Newton's bivariate interpolation for equispaced data.

**Numerical differentiation:** Derivatives using forward and backward differences up to error of second order and central differences up to error of fourth order.

**Numerical integration:** Richardson extrapolation, Romberg integration, Gaussian Quadrature, Double integration by Trapezoidal and Simpson's (1/3)<sup>rd</sup> rules.

### Unit-III

**Numerical solutions of ODE:** Picard's method, Taylor's series method for simultaneous first order ordinary differential equations and second order ODE's, Runge-Kutta method for simultaneous first order ODE and second order ODE, Linear shooting method, finite difference method and Rayleigh-Ritz method. Differential transform method for non-linear ODE's.

### Unit-IV

**Linear Algebra:** Condition number of a matrix, matrix inversion method, LU factorization method, Cholesky method, partition method, Relaxation method, bounds for Eigen values, Gerschgorin's circle theorem, Jacobi's method, Given's method.

## Unit-V

**Numerical solutions of PDE:** Numerical solution of one dimensional heat and wave equations. Von – Neumann stability of finite difference methods for wave and diffusion equations. Numerical solution of two dimensional Laplace and Poisson equations. Numerical solutions of two dimensional wave equation by ADE method, Numerical solution of two dimensional heat equation by ADE/ADI method.

### Text Books:

1. Richard. L. Burden, J. Douglas Faires, Annette M. Burden - Numerical Analysis, Brooks Cole - 10<sup>th</sup> edition, 2015.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain – Numerical methods for scientific and Engineering computation – New Age International Publisher – 6<sup>th</sup> edition, 2012.

### Reference Books:

1. Anthony Ralston, Philip Rabinowitz – A first course in Numerical Analysis – McGraw Hill Publication – 2<sup>nd</sup> edition, 2001.
2. B.S Grewal – Numerical Methods in Engineering and Science with programs in C, C++ & MATLAB – Khanna Publishers - 11<sup>th</sup> edition, 2013.
3. Steven C. Chapra – Applied Numerical Methods with MATLAB for Engineers and Scientists – McGraw Hill Publications - 3<sup>rd</sup> edition, 2011.

### ➤ Course Outcomes

On completion of this course student will have improved ability to

1. Analyze different types of errors in numerical computation and find roots of algebraic and transcendental equations and also able to solve system of non linear algebraic equations that arise in Science and Engineering problems.
2. Interpolate, Differentiate and Integrate a function for a given set of tabulated data
3. Solve initial and boundary value problems
4. Solve the system of linear equations and able to find to find eigenvalues and eigenvectors using orthogonal transformations
5. Solve PDE's arising in Science and Engineering using Numerical techniques and also able to comment on stability of numerical methods used to solve PDE's

**Note:** Demonstration of problems using Scilab.

➤ **Course Assessment and Evaluation:**

	<b>What</b>	<b>To whom</b>	<b>When/ Where (Frequency in the course)</b>	<b>Max marks</b>	<b>Evidence collected</b>	<b>Contributing to Course Outcomes</b>	
<b>Direct Assessment Methods</b>	<b>C I E</b>	Internal assessment tests	Students	Thrice(Average of the best two will be computed)	30	Blue books	1, 2,3,4,5
		Problem solving using open source software		Once	10	Program sheets	1,2,3,4
		Quiz Test		Once	10	Quiz answers	1, 2,3,4
	<b>S E E</b>	Standard examination		End of course (Answering 5 of 10 questions)	100	Answer scripts	1,2, 3,4,5
<b>Indirect Assessment Methods</b>	End of course survey	Students	End of course	- -	Questionnaire	1 to 5, Effectiveness of delivery of instructions and assessment methods	