S.No.	Topic	No.of Lectures
4.	Galerkin approach, assembly of global stiffness matrix, The finite element equation, boundary condition	3
5.	Trusses: Two dimensional problems,	3
6.	modeling by constant strain triangle	3
7.	two dimensional iso-parametric elements, the four-node quadrilateral.	3
8.	Scalar field problems, steady state heat transfer	3
9.	torsion, potential flow,	3
10.	seepage and fluid flow index, dynamic analysis, principles.	3
	Total	**32**

VII. List of Practicals

S.No.	Topic	No.of Practicals
1.	Use of simple FEM software for FEM software for understanding, principles of FEM.	3
2.	Working out simple problems using LISA or any simple software with understanding of operatio	3
3.	Solving one dimensional problem, Solution to planar and spatial trusses	2
4.	Solving simple two-dimensional problems, Axisymmetric problems	2
5.	Solution of problems with two dimensional iso-parametric elements	2
6.	Solving simple beams and frames	2
7.	Three dimensional problems, solution to heat transfer problems and flow problems.	2
	Total	**16**

VIII. Suggested Reading

- Tirupathi R, Patla C and Belegundu AD. 1999. *Introduction to Finite Element in Engineering*. Prentice Hall of India Pvt. Ltd, New Delhi
- Singiresu RaoS. 2001. *The Finite Element Method in Engineering*. Butter worth Heinemann, New Delhi.
- Rajasekaran S 1999. *Finite Element Analysis in Engineering Design*. Wheeler Publishing, Division of A.h.Wheeler and Co. Ltd, Allahabad.
- *Tutorials and Reference Guide*, LISA Finite Element Analysis Software Version 8.0.0 2013

I. Course Title : Numerical Methods for Engineers

II. Course Code : MATH 502

III. Credit Hours : 2+1

IV. Aim of the course

To expose students to various numerical methods for solving algebraic equations, ordinary and partial differential equations.

V. Theory

Unit I

Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using bisection, false position, iteration, Newton Raphson, Secant methods. Solution of linear simultaneous equations: Matrix

inversion, Gauss elimination, Gauss Jordan, LU decomposition methods, ill-conditioned systems.

Unit II

Solution of Ordinary Differential Equations: Initial Value Problem, Taylor series method, Picard's method, Euler method, Modified Euler method, RK class and predictor corrector class methods. Stiff ODE's and Gear's methods. Boundary Value Problem, Shooting methods, finite difference method. Use of Method of weighted residuals and orthogonal collocation and Galerkin technique to solve BVP in ODEs

Unit III

Eigen values and Eigen vectors: Maximum and minimum eigenvalue by Power spectral and Inverse Power Method, all eigenvalues by Fadeev-Leverrier method. Introduction to diagonalization and QR Factorization.Approximation Theory.

Unit IV

Finite difference formulae: Forward and backward differences, Richardson's extrapolation, interpolation formulae, polynomial forms, linear interpolation, Lagrange interpolation polynomial, Newton interpolation polynomial.

Unit V

Solution of Partial Differential Equations: Classification of PDEs(Parabolic, elliptical and hyperbolic equation), Elliptical equations, standard five pointsformula, diagonal five-point formula. Solution of Laplace equation by Liebman's iteration method.Poisson's equation and its applications.Solution of parabolic equations by Bender–Schmidt method, Bender-Schmidt recurrence equation, Crank-Nicholson difference method.

VI. Practical

Use of EXCEL Sheet and MATLAB: Application of EXCEL Sheet and MATLAB to solve the Engineering problems

VII. Learning outcome

Ability to solve algebraic equations, ordinary and partial differential equations coming across in Agricultural Engineering problems using various numerical methods, ability to use latest software's towards numerical problems.

VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using bisection method.	2
2.	Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using false position methods.	1
3.	Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using iteration.	1
4.	Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using Newton Raphson, Secant methods.	1
5.	Solution of linear simultaneous equations: Matrix inversion, Gauss elimination, Gauss Jordan method.	2

S.No.	Topic	No. of Lectures
6.	Solution of linear simultaneous equations: LU decomposition methods, ill-conditioned systems.	2
7.	Solution of Ordinary Differential Equations: Initial Value Problem, Taylor series method, Picard's method, Euler method, Modified Euler method	2
8.	Solution of Ordinary Differential Equations: RK class and predictor corrector class methods. Stiff ODE's and Gear's methods.	1
9.	Eigen values and Eigen vectors: Maximum and minimum eigenvalue by Power spectral and Inverse Power Method.	2
10.	Eigen values and Eigen vectors: all eigenvalues by Fadeev-Leverrier method	2
11.	Introduction to diagonalization and QR Factorization. Approximation Theory.	2
12.	Finite difference formulae: Forward and backward differences, Richardson's extrapolation, interpolation formulae, polynomial forms.	2
13.	Finite difference formulae: linear interpolation, Lagrange interpolation polynomial, Newton interpolation polynomial.	2
14.	Solution of Partial Differential Equations: Classification of PDEs (Parabolic, elliptical and hyperbolic equation)	2
15.	Elliptical equations, standard five pointsformula, diagonal five-point formula.	2
16.	Solution of Laplace equation by Liebman's iteration method. Poisson's equation and its applications.	2
17.	Solution of parabolic equations by Bender–Schmidt method	2
18.	Solution of parabolic equations by Bender-Schmidt recurrence equation, Crank-Nicholson difference method.	2
	Total	**32**

IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using bisection method.	1
2.	Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using false position methods.	1
3.	Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using iteration.	1
4.	Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using Newton Raphson, Secant methods.	1
5.	Solution of linear simultaneous equations: Matrix inversion, Gauss elimination, Gauss Jordan method.	1
6.	Solution of linear simultaneous equations: LU decomposition methods, ill-conditioned systems.	1
7.	Solution of Ordinary Differential Equations: Initial Value Problem, Taylor series method, Picard's method, Euler method, Modified Euler method	1
8.	Solution of Ordinary Differential Equations: RK class and predictor corrector class methods. Stiff ODE's and Gear's methods.	1

S.No.	Topic	No. of Lectures
9.	Eigen values and Eigen vectors: Maximum and minimum eigenvalue by Power spectral and Inverse Power Method.	1
10.	Eigen values and Eigen vectors: all eigenvalues by Fadeev-Leverrier method	1
11.	Introduction to diagonalization and QR Factorization. Approximation Theory.	1
12.	Finite difference formulae: Forward and backward differences, Richardson's extrapolation, interpolation formulae, polynomial forms.	1
13.	Finite difference formulae: linear interpolation, Lagrange interpolation polynomial, Newton interpolation polynomial.	1
14.	Solution of Partial Differential Equations: Classification of PDEs (Parabolic, elliptical and hyperbolic equation), Elliptical equations, standard five points formula, diagonal five-point formula.	1
15.	Solution of Laplace equation by Liebman's iteration method. Poisson's equation and its applications.	1
16.	Solution of parabolic equations by Bender–Schmidt method, Bender-Schmidt recurrence equation, Crank-Nicholson difference method.	1
	Total	**16**

X. Suggested Reading

- Anderson T W 1958. *An Introduction to Multivariate Statistical Analysis*. John Wiley.
- Dillon W R and Goldstein M. 1984. *Multivariate Analysis - Methods and Applications*. John Wiley.
- Electronic Statistics Text Book: http://www.statsoft.com/textbook/stathome.html
- Goon A M, Gupta M K and Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.
- Goon A M, Gupta M K and Dasgupta B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press.
- Hoel P G. 1971. *Introduction to Mathematical Statistics*. John Wiley.
- Hogg R V and Craig T T. 1978. *Introduction to Mathematical Statistics*. Macmillan.
- Montgomery and Runger 2014. *Applied Statistics and Probability for Engineers*. John Wiley
- Morrison D F. 1976. *Multivariate Statistical Methods*. McGraw Hill.
- Siegel S, Johan N and Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley.

I. Course Title : Numerical Analysis

II. Course Code : Math 506

III. Credit Hours : 2+1

IV. Aim of the course

To provide understanding and application of basic numerical techniques for evaluation and approximation of roots of polynomials, solution of differential equations, numerical differentiation and integration.

V. Theory

Unit I

Computational errors, absolute and relative errors, difference operators, divided differences, interpolating polynomials using finite differences, Hermite interpolation, piecewise and spline interpolation, bivariate interpolation.