

NATIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR
Department of Mathematics
Course Handout for Production & Industrial Eng., 4th Semester

Date: 15/01/2021

Course No.: MA 1404
Course Title: Numerical Methods and Application
Instructor in charge: Dr. Ramayana Singh

Course Description

UNIT- 1: Number systems and errors, floating point arithmetic, Loss of significance and error propagation, condition and instability, Computational methods for error estimation. Solution of nonlinear equations: Review of Bisection method, Secant and Regular- False method, Newton-Raphson method and their convergence, Fixed point iteration method and its convergence, Muller method.

UNIT- 2: Matrices and system of linear equations: Gauss elimination method and its pivoting strategy, Method of factorization, Inverse of matrix using Gauss elimination method, Error analysis of direct method, Jacobi's iterative method, Gauss- Seidel iterative method, Eigen value problems: Power method and Jacobi method.

UNIT- 3: Polynomial Interpolation and approximation: Finite difference operator: Forward difference, Backward difference operator, Central difference operator. Error propagation in difference table, Interpolating polynomials using Finite differences. Newton Forward and Backward difference interpolations, Gauss, Stirling and Bessel interpolations. Lagrange's interpolations, Newton Divided difference interpolation. Uniform approximation by polynomials. Least Square approximation by polynomials, Piecewise polynomial approximation

UNIT- 4: Differentiation and Integration: Numerical differentiation, Maxima and minima of tabulated functions. Numerical Integration: Quadrature formula, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule and their error estimations, Gaussian Integration method, Romberg integration.

UNIT- 5: Numerical solution to ordinary and partial differential equations: Taylor's series method, Euler's method. Predictor Corrector method, Runge- Kutta second and fourth order methods, local and global truncation errors, Stability of numerical methods. Classification of partial differential equations of second order, Finite difference approximation to derivatives, Solution of Parabolic and Elliptic equation

Scope: To provide good fundamental concepts of numerical methods to solve scientific problem

To make proficient in computer oriented numerical methods

Mathematical modeling and simulation for real life engineering problem.

Objective: At the end of this course, the students will be able to understand the importance and effectiveness of numerical methods in the field of science and engineering. At the end of this course, the students will be able to apply the numerical techniques in solving various kinds of problems in the field of science and engineering.

Text Books

T1: Jain, M.K. , Iiyenger, S.R.K. and Jain, R.K, "Numerical Methods for Scientific and Engineering computation.", 6th Edition, New Age International (P) limited, Publishers, New Delhi, 2012.

T2: Grewal, B.S. and Grewal, J.S., "Numerical Methods in Engineering and Science with Programs in Fortran 77, C & C++ " 7th Edition, Khanna Publishers, Delhi, 2005.

Reference Books

R1: Conte S.D. & Boor, C.D., "Elementary Numerical Analysis, An Algebraic Approach", 3rd edition, McGraw-Hill Book Company, International edition, 1981.

R2: Atkinson, K.E., "An Introduction to Numerical Analysis", 2nd Edition, Reprint, Wiley India (P), Ltd., New Delhi, 2008.

R3: Bradie, B., " A Friendly Introduction to Numerical Analysis ", 1st Impression, Pearson Prentice Hall, New Delhi, 2007.

Course plan

Lecture no.	Learning objectives	Topics to be covered	Refer to chapter, see(book)
1-4	Number systems and errors, Floating point arithmetic, Loss of significance and error propagation, Condition and instability, Computational methods for error estimation.	Number systems and errors	1(T1, R1, R2 &R3)
5-8	Review of Bisection method, Secant and Regular- False method, Newton- Raphson method and their convergence, Fixed-point iteration method and its convergence, Muller method.	The Solution of Nonlinear equation	2(T1&T1)
9-15	Gauss elimination method and its pivoting strategy, Method of factorization, Inverse of matrix using Gauss elimination method, Error analysis of direct method, Jacobi's iterative method, Gauss-Seidel iterative method, Eigen value problems: Power method and Jacobi method.	Matrices and System or Linear Equation	4(T2), 3(T1)
16-21	Forward difference, Backward difference operator, Central difference operator. Error propagation in difference table, Interpolating polynomials using Finite differences. Newton Forward and Backward difference interpolations, Gauss, Stirling and Bessel interpolations. Lagrange's interpolations, Newton Divided difference interpolation.	Polynomial interpolation	4(T1), 6-7(T2)
22-25	Uniform approximation by polynomials. Least Square approximation by polynomials, Piecewise polynomial approximation	Uniform approximation	4(T1)
26-31	Numerical differentiation, Maxima and minima of tabulated functions. Numerical Integration: Quadrature formula, Trapezoidal rule, Simpsons 1/3 rule, Simpsons 3/8 rule and their error estimatins, Gaussian Integration method, Romberg integration.	Numerical differentiation and Integration	5(T1), 8(T2)
32-36	Taylor's series method, Euler's method. Predictor Corrector method, Runge- kutta second and fourth order methods, local and global truncation errors, Stability of numerical methods	Numerical solution of ordinary differential equations	6(T1), 10(T2)
37-42	Classification of partial differential equations of second order, Finite difference approximation to derivatives, Solution of Parabolic and Elliptic equation	Numerical solution of P.D.E.	11(T2), 9-10(R3)

Evaluation scheme

ES NO.	Evaluation Component	Duration	Weightage	Date &Time	Nature of Component
1	Mid Semester Exam	2 hour.	30%	As per academic calendar	Closed Book
2	End Semester Exam	3 hour.	50%	As per academic calendar	Closed Book
4	Teacher Assessment		20%		During Class
	Surprise Quizzes/Tests, Home Assignment				

Notices: All notices regarding the course will be displayed only on the Department of the Mathematics notice board

Dr. Ramayana Singh
Instructor In-charge