SUBJECT DESCRIPTION AND OBJECTIVES

DESCRIPTION

With the present development of the computer technology, it is necessary to develop efficient algorithms for solving problems in science, engineering and technology. This course gives a complete procedure for solving different kinds of problems occur in engineering numerically.

The development and analysis of computational methods (and ultimately of program packages) for the minimization and the approximation of functions, and for the approximate solution of equations, such as linear or nonlinear (systems of) equations and differential or integral equations. Originally part of every mathematician's work, the subject is now often taught in computer science departments because of the tremendous impact which computers have had on its development. Research focuses mainly on the numerical solution of (nonlinear) partial differential equations and the minimization of functions.

Even in the absence of rounding error, few numerical answers can be obtained exactly. Among these are (1) the value of a piece-wise rational function at a point and (2) the solution of a (solvable) linear system of equations, both of which can be produced in a finite number of arithmetic steps. Approximate answers to all other problems are obtained by solving the first few in a sequence of such finitely solvable problems. A typical example is provided by Newton's method: A solution c to a nonlinear equation $f(c) = 0$ is found as the limit $c = \lim_{n \to \infty} x_n$, with X_{n+1} being a solution to the linear equation $f(x_n) f'(x_m)(x_{n+1} - x_n) = 0$, that is, $x_{n+1} = x_n - f(x_n)/(x_n)$, $n = 0, 1, 2, \ldots$ Of course, only the first few terms in this sequence x_0, x_1 x_2, … can ever be calculated, and thus one must consider when to break off such a solution process and how to gauge the accuracy of the current approximation.

OBJECTIVES

At the end of the course, the students would be acquainted with the basic concepts in numerical methods and their uses are summarized as follows:

- The roots of nonlinear (algebraic or transcendental) equations, solutions of large system of linear equations and eigen value problem of a matrix can be obtained numerically where analytical methods fail to give solution.
- When huge amounts of experimental data are involved, the methods discussed on interpolation will be useful in constructing approximate polynomial to represent the data and to find the intermediate values.
- The numerical differentiation and integration find application when the function in the analytical form is too complicated or the huge amounts of data are given such as series of measurements, observations or some other empirical information.
- Since many physical laws are couched in terms of rate of change of one/two or more independent variables, most of the engineering problems are characterized in the form of either nonlinear ordinary differential equations or partial differential equations.
- The methods introduced in the solution of ordinary differential equations and partial differential equations will be useful in attempting any engineering problem.

MA2264 NUMERICAL METHODS L T P C
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UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of equation –Fixed point iteration: x=g(x) method - Newton's method – Solution of linear system by Gaussian elimination and Gauss-Jordon method– Iterative method - Gauss-Seidel method - Inverse of a matrix by Gauss Jordon method – Eigen value of a matrix by power method and by Jacobi method for symmetric matrix.

UNIT II INTERPOLATION AND APPROXIMATION 9+3

Lagrangian Polynomials – Divided differences – Interpolating with a cubic spline – Newton's forward and backward difference formulas.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Differentiation using interpolation formulae –Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Two and Three point Gaussian quadrature formulae –Double integrals using trapezoidal and Simpsons's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step methods: Taylor series method – Euler method for first order equation – Fourth order Runge – Kutta method for solving first and second order equations – Multistep methods: Milne's and Adam's predictor and corrector methods.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9+3

Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.

TEXT BOOKS

TOTAL (L:45+T:15): 60 PERIODS

1. Veerarjan, T and Ramachandran, T., "Numerical methods with programming in C",Second Editiion, Tata McGraw-Hill Publishing.Co.Ltd, 2007.

2. Sankara Rao K, "Numerical Methods for Scientisits and Engineers", 3rd Edition, Printice Hall of India Private Ltd, New Delhi, 2007.

REFERENCE BOOKS

1. Chapra, S. C and Canale, R. P., "Numerical Methods for Engineers", 5th Edition, Tata McGraw-Hill, New Delhi, 2007.

2. Gerald, C. F. and Wheatley, P.O., "Applied Numerical Analysis", 6th Edition, Pearson Education, Asia, New Delhi, 2006.

3. Grewal, B.S. and Grewal,J.S., “ Numerical methods in Engineering and Science”, 6th Edition, Khanna Publishers, New Delhi, 2004.

MICRO LESSON PLAN

HOURS	TOPICS TO BE COVERED	REF/ TEXT BOOK
UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS		
1 – 3	Solution of equation –Fixed point iteration: x=g(x) method Newton’s method	R 3
4 - 6	– Solution of linear system by Gaussian elimination and Gauss-Jordon method	
7 - 10	Iterative method - Gauss-Seidel method - Inverse of a matrix by Gauss Jordon method	
11 - 12	Eigen value of a matrix by power method and by Jacobi method for symmetric matrix.	
UNIT II INTERPOLATION AND APPROXIMATION		
13 - 14	Lagrangian Polynomials	R 3
15 - 17	Divided differences	
18 - 20	Interpolating with a cubic spline	
21 - 24	Newton’s forward and backward difference formulas.	
UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION		
25 - 27	Differentiation using interpolation formulae	R 3
28 - 31	Numerical integration by trapezoidal and Simpson’s 1/3 and 3/8 rules– Romberg’s method	
32 - 33	Two and Three point Gaussian quadrature formulae	
34 - 36	Double integrals using trapezoidal and Simpsons’s rules	
UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS		
37 - 40	Single step methods: Taylor series method – Euler method for first order equation	R 3
41 - 44	Fourth order Runge – Kutta method for solving first and second order equations	
45 - 48	Multistep methods:Milne’s and Adam’s predictor and corrector methods.	
UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL		

DIFFERENTIAL EQUATIONS		
49 - 50	Finite difference solution of second order ordinary differential equation	R 3
51 - 55	Finite difference solution of one dimensional heat equation by explicit and implicit methods	
56 - 57	One dimensional wave equation	
58 - 60	two dimensional Laplace and Poisson equations	