
Final Exam Syllabus
Numerical Methods
Engineering Mathematics for Advanced
Studies
IIT Dharwad Autumn 2019

1. ~~Machine precision~~
 - (a) ~~Introduction to integer and float representations in digital systems~~
2. Stopping criteria - relative vs absolute
3. Errors and error propagation
 - (a) Relative and absolute error
 - (b) Bounds on error of addition/subtraction two variables with given respective error bound
 - (c) Bounds on error of multiplication/division of two variables with given respective error bound
4. Finding roots of a equation
 - (a) Fixed point iterations
 - i. Convergence criterion
 - (b) Newton Raphson method
 - (c) Newton Secant method
5. Interpolation
 - (a) Lagrange
 - (b) Cubic Spline
 - i. Formulation
 - ii. End conditions
 - iii. ~~Tension spline~~
6. Numerical differentiation
 - (a) Forward difference
 - (b) Backward difference
 - (c) Central difference
 - (d) ~~Wave number~~
 - (e) ~~Padé approximation~~
7. Numerical integration
 - (a) Rectangular rule (Midpoint Rule)
 - (b) Newton-Cotes
 - i. Trapezoidal rule
 - ii. Simpson's rule
 - (c) Gauss Quadrature (1D, 2D, 3D)
8. Error estimation
 - (a) Truncation error in numerical differentiation
 - (b) Truncation error in
 - i. Trapezoidal
 - ii. Rectangular
 - iii. Simpson's rule
9. Numerical solution of differential equations (DiffEqn)
 - (a) First order DiffEqn
 - i. Single step methods
 - A. Euler methods
 - B. Heun method
 - C. R-K methods
 - ii. ~~Multi-step methods~~
 - A. ~~Adam-Bashforth~~
 - B. ~~Adam-Moulton~~
 - (b) System of first order DiffEqn
 - i. Higher order DiffEqn
 - (c) ~~Error assessment~~
 - i. ~~Local truncation error for first order DiffEqn~~
 - ii. ~~Global truncation error for first order DiffEqn~~
 - (d) Numerical methods for
 - i. Elliptic PDE
 - ii. Parabolic PDE
 - iii. Hyperbolic PDE

- (e) ~~ADI (alternating direction implicit method)~~

10. Numerical methods in Linear Algebra

- (a) Operations counts for Gaussian elimination
- (b) Matrix factorization and their specifics
 - i. LU
 - ii. LDU
 - iii. LDL^T
 - iv. Cholskey LL^T
- (c) Ill-conditioning and numerical instability
 - i. Condition number
- (d) Special matrices
 - i. diagonal matrix
 - ii. half-bandwidth of band matrix
 - iii. numerical advantages
- (e) ~~QR factorization for least square problems~~
- (f) Indirect (iterative) methods
 - i. Jacobi
 - ii. Gauss-Seidel

- **Not covered but important topics**

Fast Fourier Transform (FFT), Eigen value estimation (Power method, Householder transformation, QR decomposition)