IT 421 : Syllabus for Numerical Techniques and Programming Lab

(Each section contains several methods. Some of them will be explicitly taught in the class and some will be given as task to solve by the students)

1) The Solution of Nonlinear Equations f(x) = 0

1. Fixed Point Iteration
2. Bisection Method
3. False Position or Regula Falsi Method
4. Newton-Raphson Method
5. Secant Method
6. Muller's Method
7. Aitken's Method & Steffensen's Acceleration
8. Accelerated & Modified Newton-Raphson
9. Improved Newton Method
10. Halley's Method
11. Homer's Method
12. Lin-Bairstow Method
13. Brent's Method
14. Graeffe's Method
15. Nonlinear Systems
16. Broyden's Method

2) The Solution of Linear Systems AX = B

1. Triangular Systems and Back Substitution
2. Gauss-Jordan Elimination and Pivoting

3 Tri-Diagonal Matrices

4. Inverse Matrix
5. LU Factorization
6. Cholesky, Doolittle and Crout Factorizations
7. Jacobi and Gauss-Seidel Iteration
8. Successive Over Relaxation - SOR
9. Pivoting Methods
10. Iterative Refinement
11. Row Reduced Echelon Form
12. Homogeneous Linear Systems
13. Kirchoffs Law
14. Leontief Model
15. Linear Programming-Simplex Method

3) Interpolation and Polynomial Approximation

1. Maclaurin and Taylor Series
2. Lagrange Polynomial Interpolation and Approximation
3. Newton Interpolation Polynomial
4. Hermite Polynomial Interpolation
5. Cubic Splines
6. B-Splines
7. Bezier Curves Bezier Curves
8. Chebyshev Approximation Polynomial
9. Pade Approximation
10. Rational Approximation
11. Aitken's and Neville's Interpolation
12. Legendre Polynomials

13. The Tangent Parabola
14. Catenary

4) Curve Fitting

I. Least Squares Lines
2. Least Squares Polynomials
3. Nonlinear Curve Fitting
4. Logistic Curve
5. EFT and Trigonometric Polynomials
6. Conic Fit
7. Circle of Curvature

5) Numerical Differentiation

1. Numerical Differentiation
2. Richardson Extrapolation
3. Derive Numerical Differentiation Formulae

6) Numerical Integration

I. Riemann Sums
2. Midpoint Rule
3. Newton-Cotes Integration
4. Trapezoidal Rule for Numerical Integration
5. Simpson's **aule for** Numerical Integration
6. Simpson's 3/8 Rule for Numerical Integration
7. Boole's Rule
8. Romberg Integration
9. Adaptive Simpson's Rule
10. Gauss-Legendre Quadrature
11. Cubic Spline Quadrature
12. Monte Carlo Pi
13. Monte Carlo Integration
14. 2D Trapezoidal and Simpson Rules

7) Solution of Differential Equations

1. **Eulees** Method for ODE's
2. Taylor Series Method for ODE's
3. Runge-Kutta Method
4. Runge-Kutta-Fehlberg Method
5. Adams-Bashforth-Moulton Method
6. Milne-Simpson's Method
7. Predictor-Corrector Methods
8. Shooting Methods for ODE's
9. Finite Difference Method for ODE's
10. Galcrkin's Method
11. II. Painleve Property
12. Lotka-Volterra Model
13. Pendulum
14. Projectile Motion
15. Lorenz Attractor
16. van der Pol System
17. Harvesting Model
18. Frobenius Series Solution
19. Picard Iteration
20. Spring-Mass Systems

8) Solution of Partial Differential Equations

1. Finite Difference Method
2. Crank-Nicolson Method
3. Elliptic PDE's

9) Eigenvalues and Eigenvectors

1. Eigenvalues and Eigenvectors
2. Power method
3. Jacobi method
4. Householder Transformations
5. QR method
6. Compartment Model
7. Earthquake Model
8. Matrix Exponential
9. Faddeev-Leverrier Method
10. Hessenberg Factorization

10) Numerical Optimization

1. Golden Ratio Search
2. Fibonacci Search
3. Quadratic Interpolative Search
4. Nelder Mead Method
5. Powell's Method
6. Steepest Descent - Gradient Search
7. Newton's Search Method