Linear Algebra
&
Numerical Methods

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Course Outline

Part I: Linear Algebra

- **Systems of Linear Equations and Matrices**
- **Linear Equations,**
- **Introduction to Linear Systems**
- **The Geometry of Linear Equations**
- **General Linear Form**
- **Matrix Form**
- **Elementary Row Operations**
- **Gaussian Elimination**
- **Gauss Jordan Elimination, Row Echelon Form, Reduced Row Echelon Form**
- **Matrices and Matrix Operations**
- **Determinants**
- **Linear Independence and Rank of Matrix**
- **Eigenvalues and Eigenvectors**
- **Solving Linear Systems by Factoring**
- **MATLAB Applications**

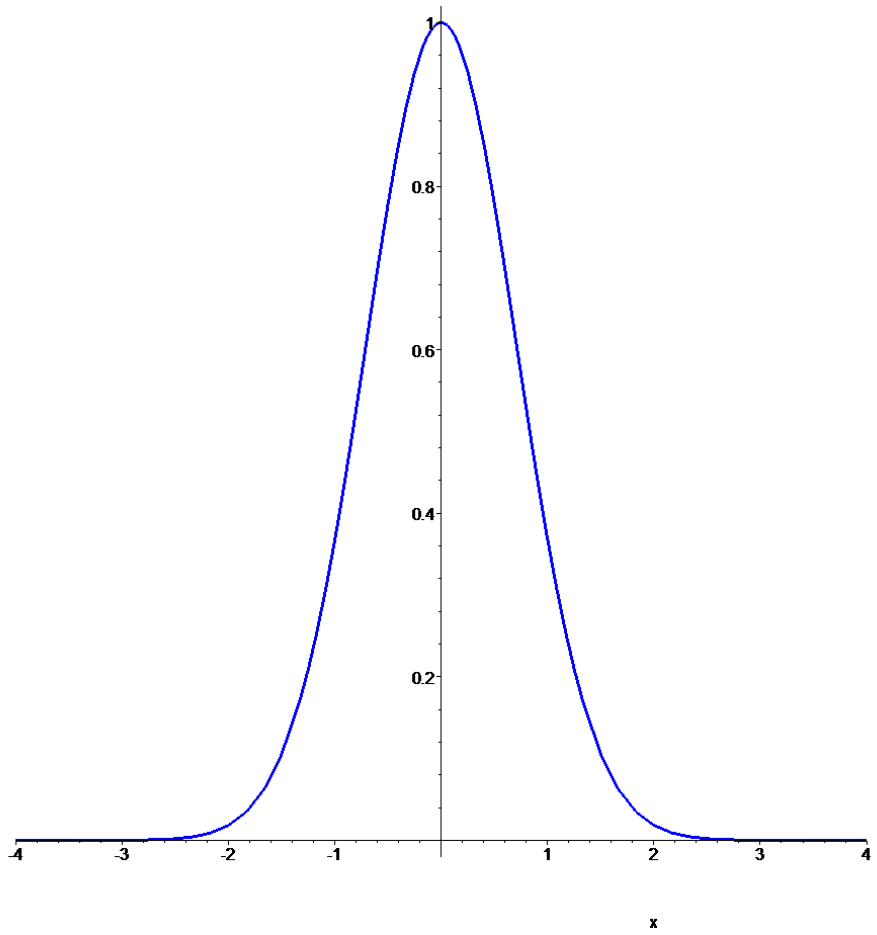
Part II: Numerical Methods

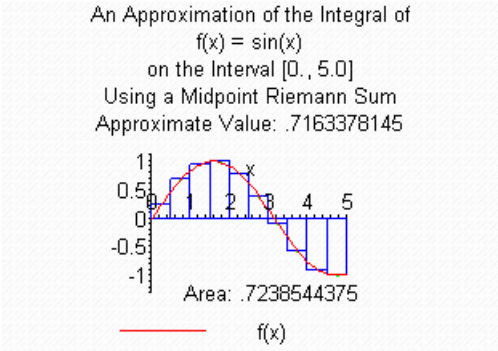
- **Introduction to Numerical Methods, Numerical Errors, Convergence of Numerical Algorithms**
- **Iterative Techniques for Solving Linear Systems**
- **Numerical Integration**
- **Computation of Zeros, Solving Nonlinear Equations**
    - **Bisection Method**
    - **Newton's Method**
    - **Regula Falsi**
    - **Muller's Method**
    - **Fixed Point Iteration**
- **Solution of Nonlinear Systems**
    - **Fixed Point Iteration**
    - **Newton's Method**
    - **Gradient Descent Method**
- **Taylor Series and Calculation of Function**
- **Interpolation and Lagrange Polynomial**
- **Newton Polynomials and Divided Differences**
- **Hermite Interpolation and Spline Interpolation**

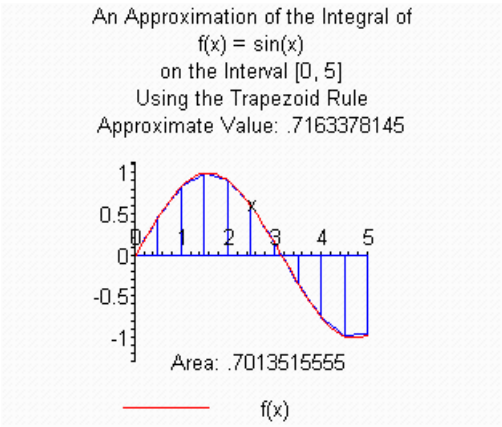
- **Curve Fitting**
- **Data Linearization**
- **Least Square Polynomials**
- **Multiple Regression**
- **Fourier Series and Trigonometric Polynomials**

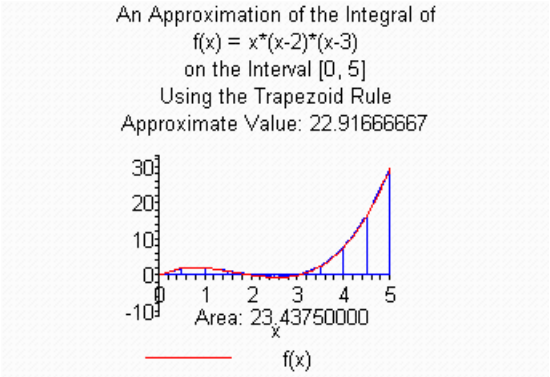
```
> int(exp(-x^2),x);
```

$$\frac{1}{2}\sqrt{\pi}\,\mathrm{erf}(x)$$




An Approximation of the Integral of
f(x) = sin(x)
on the Interval [0., 5.0]
Using a Midpoint Riemann Sum
Approximate Value: .7163378145
1
0.5
0
-0.5
-1
0
1
2
3
4
5
x
Area: .7238544375
f(x)


An Approximation of the Integral of
f(x) = sin(x)
on the Interval [0, 5]
Using the Trapezoid Rule
Approximate Value: .7163378145
1
0.5
0
-0.5
-1
0
1
2
3
4
5
x
Area: .7013515555
f(x)


An Approximation of the Integral of
f(x) = x*(x-2)*(x-3)
on the Interval [0, 5]
Using the Trapezoid Rule
Approximate Value: 22.91666667
30
20
10
0
-10
0
1
2
3
4
5
x
Area: 23.43750000
f(x)

References

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2. **Elementary Linear Algebra, Howard Anton, Chris Rorres, Wiley International Edition.**
3. **Linear Algebra and Its Applications, Gilbert Strang, International Student Edition.**
4. **Linear Algebra, Walter Nef, McGraw-Hill Book Company**
5. **MATLAB, Uğur Arifoğlu.**
6. **Matrix Operations Richard Bronson, Schaum's Outlines, Nobel Yayıncılık**
7. **Linear Algebra, Seymur Lipschutz, Schaum's Outlines, Nobel Yayıncılık**
8. **Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, McGraw-Hill.**
9. **An Introduction to Numerical Computations, Sidney Yakowitz, Ferench Szidarovszky, Maxwell Macmillan.**
10. **Numerical Analysis, Richard Burden, Prindle, Weber&Schmidt.**
11. **Applied Numerical Analysis, Gerald Wheatley, Pearson.**
12. **Numerical Methods Using MATLAB, John H. Mathews, Kurtis D. Fink, Pearson.**
13. **Applied Numerical Analysis Using MATLAB, L.V. Fausett, Prentice Hall.**
14. **Basic Numerical Methods, R.E. Scraton, Edward Arnold.**
15. **Numerik Analiz, Schaum's Outlines Francis Scheid, Çeviri: Prof. Dr. Hilmi Hacısalihoğlu, Nobel Yayın Dağıtım.**

Using Computers in Linear Algebra and Numerical Methods

Many computer algebra systems are available.

- **MATLAB**
- **MATHEMATICA**
- **MAPLE**
- **MATRIXPAD**
- **MACSYMA**
- **..**

MATLAB is command line driven, meaning that we type in commands that invoke operations. It is a large and powerful "computing environment".

MathWorks, the developer of the program calls it "The language of Technical Computing".

Commercial software packages are available.

- **IMSL (International Mathematical and Statistical Library)**
- **NAG (Numerical Algorithms Group)**
- **LAPACK(Linear Algebra Package)**

Systems of Linear Equations and Matrices

Linear equations arise frequently in the

- **Analysis,**
- **Design and**
- **Synthesis of**

engineering systems.

Application Areas:

- **Image and picture processing,**
- **Computer animation,**
- **Computer graphics,**
- **Computer performance evaluation,**
- **Searching for optimal conditions, (OR)**
- **Modeling real life problems.**

Some Specific Applications

- **Constructing Curves and Surfaces through Specified Points**
- **Electrical Networks**
- **Geometric Linear Programming**
- **Cubic Spline Interpolation**
- **Markov Chains**
- **Graph Theory**
- **Games of Strategy**
- **Economic Models**
- **Computer Graphics**
- **Computed Tomography**
- **Fractals**
- **Chaos**
- **Cryptography**
- **Genetics**
- **Age-Specific Population Growth**
- **Harvesting of Animal Populations**