Intermediate Algebra for the Applied Sciences

The Official Committee Topical Wish-List

Philosophy: This course is about providing students with mathematical tools necessary for success in scientific and vocational disciplines. Topics mirror those in intermediate algebra, but the approaches tend to be more focused toward scientific analysis. Our goal is to let applications drive topics, and spend more time on algebraic manipulation on expressions related to models of applied phenomena, and less on exotic algebraic expressions with no clear application.

Scientific Essentials
- Percents and Proportions – Direct, Inverse, Joint
- Properties of Exponents, Radicals, and Scientific Notation
- Systems of Measurement: English and Metric
- Error in Measurement vs. Error in Computed Values & Propagation of Error
- Units and Unit Conversion

Functions and Technology
- Functions and Function Notation
- Domain and Range
- Graphing Functions
- Solving Equations Numerically – Searching for Sign Changes for Roots of Functions
- Graphing Calculators: Graphs, Tables, Data Collectors in Science Labs, Curve Fitting, Root Finding
- Computer Algebra Systems: Graphs, Curve Fitting, Root Finding

Statistics Essentials
- Measures of Center
- Measures of Variation
- Measures of Position – Percentiles and Standardized Scores
- Scatter Plots

Linear Models
- Solving linear equations
- Applications of linear equations
- Linear equations in Two Variables
  - Slope as rate of change, $m = \Delta y / \Delta x$, $y$-Intercept as initial value
  - Point-slope form, Slope-intercept form
- Linear Models: $y = mx + b$
- Error in estimates using linear models: $\Delta y = m \cdot \Delta x$
- Solving Equations Numerically – The Secant Line Method

Linear Systems
- Solving Linear Systems: Graphically, by Substitution, by Elimination
- Underdetermined Systems, Over-determined Systems
- Matrices and Matrix Algebra including Multiplication, Inversion, and Transposition
- Vectors and Vector Operations, Vector Dot-Product, Orthogonality, and Vector Projections $\text{Proj}(\vec{v}, \vec{w}) = \frac{\vec{v} \cdot \vec{w}}{\vec{w} \cdot \vec{w}} \vec{w}$.
- Matrix Representation of Linear Systems $A \cdot \vec{x} = \vec{b}$
- Solving $A \cdot \vec{x} = \vec{b}$ using Gaussian Elimination of Augmented Matrix
- Solving $A \cdot \vec{x} = \vec{b}$ as $\vec{x} = A^{-1} \cdot \vec{b}$
- Determinants
- Cramer’s Rule
- Least-Squares Solution of an Over-determined System $A \cdot \vec{x} = \vec{b}$ using $A^T \cdot A \cdot \vec{x} = A^T \cdot \vec{b}$.
  (This is a generalization of Vector Projections above).
- Linear Regression using Least Squares Solution of an Over-determined System
- Multiple Regression Using Least Squares $A^T \cdot A \cdot \vec{x} = A^T \cdot \vec{b}$
Quadratic Models
- Quadratic Equations
- Solving Quadratic Equations Using the Quadratic Formula
- Quadratic Equations in Applications
- Graphing Quadratic Equations in Two Variables
- Quadratic Models and Optimization Problems
- Fitting Quadratic Models to Paired Data using Least Squares Methods. \( A^T \cdot \bar{x} = A^T \cdot \bar{y} \)

Rational Models
- Domain for Rational Expressions
- Solving Rational Equations
- Rational Models and Asymptotic Behavior in Applications
- Fitting Rational Models to Paired Data in Proportionalities using Least Squares Methods

Radical Models
- Properties of Radicals, Domain for Radical Expressions
- Solving Radical Equations
- Radical Equations in Applications
- Graphing Radical Equations in Two Variables
- Modeling with Functions Containing Radicals
- Error in Models Containing Radicals
- Fitting Paired Data to Functions Containing Radicals using Least Squares Methods

Exponential and Logarithmic Models
- Exponential Functions, Models, and Graphs
- Inverse Functions
- Logarithmic Functions, Graphs, and Properties including Change of Base
- Solving Exponential and Logarithmic Equations
- Exponential and Logarithmic Models in Applications
- Error in Exponential and Logarithmic Models
- Time Value of Money for Annuities, Loans, and other Investments
- Fitting Paired Data to Exponential and Logarithmic Models using Least Squares Methods

Sequences and Series
- The Importance of Infinite Sequences and Series in Approximation Theory
- The Infinite Series for \( e^x \) and \( \ln(x) \) and Error in Estimates.
- The Binomial Theorem
- Difference Equations

Probability
- Basic Notions
- Error in Relative Frequencies and the Law of Large Numbers
- The Multiplication Rule and Independence
- The Addition Rule and Mutual Exclusivity
- Discrete Random Variables
- Binomial Experiments and The Binomial Theorem