Course Outline: Numerical Methods for Beginners

Course Overview:

* **Course Title:** Numerical Methods
* **Course Level:** Beginner
* **Target Audience:** Undergraduate students pursuing a Bachelor's degree
* **Duration:** 7 weeks
* **Credits:** 4
* **Structure:** 8 Modules
* **Delivery Mode:** Online

Course Objectives:

* Gain a comprehensive understanding of the fundamental principles of numerical methods
* Develop practical skills in applying numerical methods to solve real-world problems
* Enhance problem-solving abilities and analytical thinking

Bloom's Taxonomy Integration:

Each module will incorporate Bloom's Taxonomy levels from knowledge and comprehension to application, analysis, evaluation, and synthesis.

Course Structure:

Module 1: Introduction to Numerical Methods

*** **Introduction:** Importance and relevance of numerical methods**

*** **Key Concepts:** Definition, types, and applications of numerical methods**

*** **Real-World Applications:** Case study of using numerical methods in engineering, science, and finance**

*** **Interactive Elements:** Simulation of numerical methods using online tools**

****Module 2: Root Finding and Nonlinear Equations****

*** **Introduction:** Overview of root finding methods**

*** **Key Concepts:** Bisection, secant, and Newton-Raphson methods**

*** **Real-World Applications:** Numerical solution of polynomial equations and optimization problems**

*** **Interactive Elements:** Graphical representation of root finding algorithms**

****Module 3: Linear Systems and Matrix Operations****

*** **Introduction:** Types and properties of linear systems**

*** **Key Concepts:** Gauss-Jordan elimination, Cramer's rule, and matrix inversion**

*** **Real-World Applications:** Solving simultaneous equations in various fields**

*** **Interactive Elements:** Online matrix calculator for practice**

****Module 4: Numerical Integration****

*** **Introduction:** Concepts of definite and indefinite integrals**

*** **Key Concepts:** Trapezoidal, Simpson's, and Gaussian quadrature rules**

*** **Real-World Applications:** Calculating areas, volumes, and other geometric quantities**

*** **Interactive Elements:** Simulation of integration algorithms**

****Module 5: Numerical Differentiation****

*** **Introduction:** Derivatives and their numerical approximation**

*** **Key Concepts:** Forward, backward, and central difference methods**

*** **Real-World Applications:** Interpolation, curve fitting, and data analysis**

*** **Interactive Elements:** Visual representation of differentiation algorithms**

****Module 6: Differential Equations****

*** **Introduction:** Types and characteristics of differential equations**

*** **Key Concepts:** Euler's method, Runge-Kutta methods, and finite difference methods**

*** **Real-World Applications:** Modeling real-life phenomena in science, engineering, and finance**

*** **Interactive Elements:** Simulation of differential equation solvers**

****Module 7: Interpolation and Curve Fitting****

*** **Introduction:** Need for interpolation and curve fitting**

*** **Key Concepts:** Polynomial, spline, and least squares methods**

*** **Real-World Applications:** Smoothing data, predicting trends, and approximating functions**

*** **Interactive Elements:** Curve fitting tool for hands-on practice**

Module 8: Optimization

* **Introduction:** Concepts of unconstrained and constrained optimization
* **Key Concepts:** Gradient descent, Nelder-Mead, and Lagrange multipliers
* **Real-World Applications:** Finding optimal solutions in various domains
* **Interactive Elements:** Optimization solver with visual feedback