CST-305 Project 6: Numerical Computations with Taylor Series and Polynomials

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**Project Overview**

This project demonstrates the use of Taylor series and numerical methods for solving ordinary differential equations (ODEs). It includes polynomial approximations, analytical methods, and simulations of system performance through differential modeling.

**Part 1: Taylor Polynomial Approximations**

**Part 1(a)**

We solve a second-order differential equation using a 4th-degree Taylor polynomial around x = 0. The equation used is: y'' - 2xy' + x²y = 0 with initial conditions y(0) = 1 and y'(0) = -1.

**Part 1(b)**

This part involves solving a different ODE using a second-degree Taylor approximation. We approximate y near x = 3 using y(3) = 6 and y'(3) = 1. The second derivative is calculated and used to estimate values.

**Part 2: Numerical Solution Using solve\_ivp**

We use SciPy's solve\_ivp to solve the nonlinear ODE: y'' = (x - y) / (x² + 4) with initial values y(0) = 1 and y'(0) = 0. This produces a numerical solution over the interval [0, 0.5].

**Part 3: System Performance Model**

We simulate the performance decay of a computer system over time using the ODE: dP/dt = -0.1P - 1.8. The model is implemented using `odeint`, which numerically integrates the system's performance from an initial level of 100. This models degradation due to processing load or thermal effects.

**Ethical and Professional Considerations**

When designing computer systems, engineers must consider cost vs. performance trade-offs. Using mathematical models helps make informed decisions balancing resource efficiency and processing speed. Ethically, designers should ensure systems do not overpromise capabilities and adhere to legal standards such as energy compliance and reliability metrics.