African Topology Studies (Pure Science)

Nonlinear Differential Equations for Power-Grid Forecasting in Nigeria: Stability Analysis and Convergence Proofs

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Abstract

This study addresses the challenge of forecasting power-grid behaviour in Nigeria, a critical sector for national energy security and stability. A novel approach is adopted to derive the nonlinear differential equation governing power-grid dynamics. Stability analysis is performed using Lyapunov's direct method, and convergence proofs are conducted under suitable assumptions. The model exhibits stable behaviour for a range of initial conditions, with convergence rates that vary according to grid load parameters. This study establishes the theoretical foundation for reliable power-grid forecasting in Nigeria using nonlinear differential equations, providing a robust mathematical framework. Further research should focus on validating these models through real-world data and exploring their applicability across different geographical regions. Nonlinear Differential Equations, Power-Grid Forecasting, Stability Analysis, Convergence Proofs The analytical core is $\hat{\{} y\} t = mathcal\{F\}(xt;\theta)$ with $\hat{\{}\theta\} = argmin_{\theta} L(\theta)$, and convergence is established under standard smoothness conditions.

Keywords: *Sub-Saharan, Africa, Nonlinearity, Differential, Equations, Stability, Convergence*

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