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Fourth-Order Differential Equations its Solution and Applications in Science and Engineering

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Abstract: *Fourth-order differential equations arise in diverse branches of science and engineering, describing complex systems where second-order models are insufficient to capture higher-order effects such as bending stiffness, dispersion, or fine-scale interactions. In this paper fundamental theory of fourth-order differential equations and their applications across physics, mechanical engineering, materials science, structural engineering, fluid mechanics, biomedical engineering, and environmental sciences. Real-world examples and governing equations are provided for each domain, highlighting their role in modeling beam deflection, thin plate theory, optical systems, biological tissue mechanics, and hydrodynamic stability. The paper also emphasizes the mathematical formulations, analytical and numerical solution techniques, and their relevance to modern research.*

Keywords: Fourth-order differential equation, beam deflection, thin plate theory, biophysics, hydrodynamics, optics, elasticity, applied mathematics, PDEs, vibration analysis