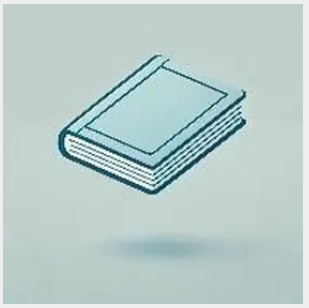
Chen

Fractional Calculus for Complex Systems

This volume in the Encyclopedia of Complexity and Systems Science, Second Edition, offers a detailed account of fractional calculus tools, signatures of complex systems, hidden connections to fractional calculus, and applications and case studies involving fractional calculus in complex signal analysis and complex system modelling, analysis and control (MAD). The authors document both the foundational concepts of fractional calculus in complexity science as well as their applications to, and role in, the optimization of, complex engineered systems. Fractional calculus is about differentiation and integration of non-integer orders. Convenience has driven the use of integer-order models and controllers for complex natural or man-made systems, but these traditional models and tools for the control of dynamic systems may result in suboptimum performance and even “anomalous” behavior. In contrast, a growing literature documents “more optimal” performance when fractional order calculus tools are applied. From an engineering point of view, new and beneficial uses of this versatile mathematical tool are both possible and important, and may become an enabler of new scientific discoveries.

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