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Guest Editorial

Special Section on Fractional Operators in the Analysis of Mechanical Systems Under Stochastic Agencies

The fractional calculus, namely, the calculus of integrals and derivatives of real or complex order, has captured considerable popularity and importance in engineering applications during the last decades. The considerable number of scientific publications concerning fractional calculus and its applications in various and widespread fields of science and engineering demonstrates the importance of this mathematical tool. The growing interest in this field is due to the fact that the generalization of differential and integral operators provides some new tools to model, simulate, represent, and solve different kinds of engineering problems. Some examples are viscoelasticity, diffusive transport, electrical networks, probability and statistics, control theory of dynamical systems, chemical physics, optics and signal processing, and so on. Moreover, recently some important applications have regarded various engineering problems in stochastic mechanics. In fact, it has been proved that the fractional calculus is a valuable mathematical tool for the characterization of stochastic processes and random variables, for the simulation of external loads on structures, for the modeling of the internal damping of the medium, for the solution of the Fokker–Planck equation, etc. Basically, the fractional operators are commonly used as purely mathematical tools to solve stochastic differential equations and/or to describe and model mechanical behavior of real structures. In the first case, some contributions regard the solution of Langevin equations, the use of Mellin transform for the evaluation of complex-order spectral moments, the description of random variable and random processes, etc. In the second case, several applications of Caputo and Riemann–Liouville operators have showed the capabilities of these operators in the description of the mechanical behavior of structures and the modeling of real material constitutive laws. In particular, they are able to model nonlocality, viscoelasticity and fading memory effect, multiscale structures, Brownian motions and anomalous diffusion, etc.

This Special Section of the *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems: Part B—Mechanical Engineering* aims to provide advanced developments in the applications of fractional calculus in various problems of stochastic mechanics with emphasis on risk evaluation and uncertainty quantification. It is composed of eight papers written by researchers and academics from China, Germany, Italy, Spain, and UK. The papers cover theoretical issues, computational methods and modeling techniques of structures, and external agencies in order to refine the actual methods used in practical engineering problems, with particular regards to the stochastic mechanics context. In particular, there are some new results about the solution of barrier problem of noisy dynamical system embedded with fractional derivative, the estimation of the random temperature effects in the viscoelastic behavior of hereditary materials, the parametric study of stochastic variation of the fractional Laplacian order in the nonlocal structural element, the exact evaluation of response fractional spectral moments of linear fractional oscillators excited by a white noise, the path integral method for nonlinear system under Levy white noise, the use of fractional operators in the interval analysis, the stochastic dynamical analysis of primary suspension in railway vehicle modeled by fractional operators, and the analysis of nonlocal viscoelastic nanorod forced by Gaussian noise.

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