Preface

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Uncertainties are present and inevitable in many engineering decision-making problems. Strategies to reduce them or to account for their effects have become increasingly important. Recent years have seen advances in the use of probabilistic concepts and analysis methods in engineering reliability assessment, system identification and health monitoring. The general trend has been towards applications for complex engineering problems that are characterised by a large number of uncertain/design variables, advanced stochastic model description, non-linear system behaviour, multiple-failure criteria, etc. This special issue aims at bringing together recent research findings in the application of

probabilistic methods in reliability analysis and system identification. The papers selected contribute to developing advanced analysis methods in stochastic dynamics systems, effective methods for calculating system reliability of general systems, Bayesian approach for structural damage detection and application of advanced stochastic algorithms to solving complex problems. It covers a wide range but nevertheless a limited snapshot of the broad variety and fast pace of research activities that have been on-going in this field.

The first two papers contribute to developing advanced reliability method for nonlinear stochastic structural systems. Katafygiotis et al. propose a novel Subset Simulation method that is based on a spherical representation of the underlying uncertainties. A slice-sampling algorithm is developed to efficiently propagate the samples. The method is applicable to general non-linear systems with possibly a large number of random variables. Jensen et al. propose an efficient method to carry out reliability-based structural optimisation of non-linear systems under stochastic loading and multiple first passage probability constraints. They propose a sequential approximate optimisation scheme that leverages on local approximation of first excursion probabilities on the design variables.

Acar et al. developed an approximate method for structural reliability analysis under static loads. Their method fits an extended generalised lambda distribution to the reliability function, making use of statistical moments of the performance function. The moments are estimated using a univariate dimension-reduction method based on additive decomposition of the performance function. As the method is based on heuristic fitting with standard distribution, the authors recommend limiting its use to structural problems with moderate levels of reliability. Fiondella and Gokhale proposed an analytical method for approximating the system reliability of redundant systems with correlated failures. They derive approximate expressions for the reliability of k-out-of-n series-parallel systems. Their numerical results indicate that the method is capable of capturing the trends in system reliability.

Two papers contribute to the field of system identification and decision making under uncertainties. Gaitanaros et al. propose a Bayesian system identification method for estimating the crack location, size and orientation in a structure using strain measurements. The method combines information from measured data and theoretical models and rigorously addresses the effect of uncertainties arising from modelling and measurement errors. They also propose a method for determining the optimal deployment of sensors by maximising the information gained from measured data. Ahmad studied the optimal accelerated life-test designs for generalised exponential distribution with a log-linear model under periodic inspection and Type I censoring. Analytical results were derived and applied to provide guidelines for planning accelerated life tests.

The last three papers present development and application of advanced stochastic algorithms to solving complex problems of interest. Chetouani constructed an artificial neural network to model the behaviour of a distillation column with a non-linear auto-regressive moving average exogenous model. The study analyses the input choice, time delay, hidden neurons and their influence on the behaviour of the neural estimator. Kumar et al. proposed heuristic methods for solving constrained redundancy allocation problems in complex network systems. Their study indicates that the use of sensitivity factors can significantly improve computational efficiency. Zeblah et al. developed an efficient method based on harmony search to solve redundancy optimisation problems that involve selecting components and redundancy levels to maximise system reliability. Their method adopts a universal moment-generating function to accelerate computations.

In summary, this special issue serves to reveal some of the recent developments in the advances of reliability methods, probabilistic system identification and stochastic algorithms. At any rate, computational efficiency and application robustness always play a trade-off in any method, respecting which can help steer the direction where research efforts should be devoted for making algorithms more sustainable, amidst the exponential growth in computer speed that renders some traditional methods now irrelevant.