Short-Term Course on

Intelligent Monte Carlo Simulations and Machine Learning-Based Methods in Computational Structural Reliability

[Supported by SPARC]

Course Schedule

Dates: 5-9 July 2024
Mode: In person
Venue: Department of Civil Engineering,
Indian Institute of Science, Bangalore 560012

For Registration

https://iisc.online/shortterm/home.html

Contact us

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Profile of the Participants

The course is aimed at faculty members from engineering colleges (in the areas of civil, mechanical, aerospace, automotive engineering), research scholars engaged in research in the broad area of uncertainty quantification in structural engineering, scientists from research laboratories, and industrial practitioners (in the areas of structural engineering, aerospace and defence applications, railway and highway engineering, and automotive engineering who need to deal with uncertainties in loading and structural systems).

Pre-requisites

- Desirable minimum qualification: M Tech in Civil/Mechanical/Aerospace/Automotive Engineering or equivalent.
- Exposure to subjects of probability, random processes, and machine learning would be an advantage but not essential.

Course Fee
Students: INR 5000.00 + 18% GST
Faculty Members from Educational Institutes: INR 10000.00 + 18% GST
Participants from R&D Labs and Industry: INR 20000.00 + 18% GST

The course fee includes expenses towards course material, refreshments and lunch during the course, and does not include expenses towards travel, accommodation, breakfast, and dinner. Limited on campus accommodations at the Hoysala Guesthouse are available (on payment basis) and these will be provided by the Centre for Continuing Education on first come first served basis.

Instructors

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Professor
Department of Civil Engineering,
Department of Mechanical Engineering,
and Department of Material Science and
Nano-Engineering,
Rice University, Texas, USA
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Course Content

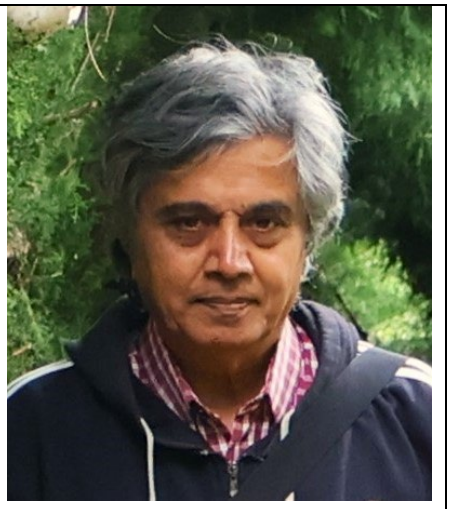
A brief review of probability, random variables, and random processes. Background to reliability integral. Component and system reliability. Time variant and time-invariant reliability. Review of analytical approximations: FORM and related issues. Review of random number generations. Simulations of scalar/vector random variables/processes. Treatment of non-Gaussianity and dependence. Simulations from partially specified models. Markov chain Monte Carlo samplers. Monte Carlo simulations for reliability integral estimation. Importance sampling. Particle splitting methods. Subset simulation methods. Girsanov transformations and time-variant reliability estimation. Reliability estimation with finite element structural models: surrogate models and kriging. Review of machine learning algorithms for regression and classification problems. Background to active learning and reinforcement learning. Applications in structural reliability modeling. Sparse polynomial chaos expansion-based least angle regression. Overview of Bayesian network reliability.

About the Course

The subject of structural reliability forms the backbone of several problems in modern structural engineering including those that arise in prescriptive code development, performance-based structural engineering, structural robustness, and infrastructure resilience. Several areas of engineering including structures under loads induced by earthquake, wind, waves, guideway unevenness, and fire have witnessed the application of reliability-based tools in the domains of their design and maintenance. There have been significant advances in recent years in the area of computational reliability modelling which combine Monte Carlo simulations, finite element structural system modelling, meta model development, and machine learning based methods. The primary aim of this course is to systematically introduce these tools and methods and discuss the more recent advances in this area. This course is organized as a part of a SPARC funded project titled “Quantification of resilience of transportation infrastructure in north India exposed to large Himalayan earthquakes” which is a collaborative project among IIT-Kharagpur, IIT-Madras, Rice University (USA), Texas A &M University (USA), and IISc.

About the Speakers

C S Manohar received his PhD from IISc in 1990 and subsequently worked as a Scientist at SERC Madras (1990-91) and as a research assistant at the University of Oxford (1991-93). He joined IISc as a faculty member in 1993 where he continues to serve till present. He has long standing research interests in the areas of uncertainty modelling, structural reliability modelling, random vibrations, structural system identification, and earthquake engineering. He has published 90+ Journal papers in these areas of research and has mentored 14 PhD students, 20 M Tech (Research) students, and 65 M Tech project students in these areas of research. He has received extensive research funding from various agencies including BRNS, DST, CSIR, ARDB, Indian Railways, ISRO, and UKIERI and has also served as a consultant to various agencies including GE (India), Honeywell, IGCAR, Mfar Holdings, BHEL, EMRC, RPCL, and DRDO labs. He has held visiting faculty positions at Johns Hopkins University (USA), the University of Delaware (USA), and Carleton University (Canada). He has been on the Editorial Board of several journals, including ASCE Journal of Structural Engineering, Probabilistic Engineering Mechanics, Structural Safety, and Structural Control and Health Monitoring. He is one of the Senior Editors of Sadhana (Academy Proceedings in Engineering Sciences, Indian Academy of Science).



Satish Nagarajaiah is a Professor of Civil Eng. and Professor of Mechanical Eng., Material Science Nano-Engineering, at Rice University, Texas, USA. His teaching and research focus on structural dynamics, seismic isolation, adaptive stiffness structural systems, structural control/monitoring, sparse structural system identification, physics-guided machine learning, and noncontact strain sensing using nanomaterials. He has made pioneering contributions to the development of (1) algorithms for nonlinear dynamic analysis of seismically isolated structures that have been implemented widely in practice, the latest being in $5B Apple Headquarters Spaceship building in California, (2) adaptive stiffness structural systems—particularly adaptive passive negative stiffness systems implementable in large structures, smart/adaptive passive tuned mass dampers for buildings and bridges, (3) non-contact smart strain sensing skin made of carbon nanotubes for producing strain maps—unlike any other existing technology, and (4) widely cited sparse structural system identification with machine learning algorithms. His outstanding contributions have been recognized by (1) the National Science Foundation CAREER award in 1999, (2) the Moissieff Award by ASCE in 2015, (3) the Raymond Reese Research Prize by ASCE in 2017, (4) the Takuji Kobori Prize by IASCM in 2019, and (5) the prestigious Nathan M. Newmark Medal jointly by ASCE SEI & EMI in 2020. In recognition of his important inventions and pioneering contributions, Nagarajaiah was elected to the United States National Academy of Inventors (F.NAI) in 2019 and elected Distinguished Member of ASCE in 2021. He was elected a Member of Sigma Xi, Scientific Research Honor Society (founded in 1886). He is the editor of the Structural Control and Health Monitoring International Journal [SCHM—Wiley] and Structural Monitoring Maintenance, International Journal, Techno-Press. He served as the managing editor of the ASCE Journal of Structural Engineering from 2011-2018. He is a Fellow of ASCE (2017) and a Fellow of SEI (2012).