Passive, Semi-Active and Active Methods of Vibration Control of Machines and Structures

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This tutorial focusses on vibration control of mechanical systems and structures. The presentations will cover aspects of passive, semi-active and active control. Three connected topical elements of vibration control will be considered.

Theory, Modelling & Hardware Realization of Vibration Isolators - Prof. Asok Kumar Mallik

The principles of vibration isolation and the characteristics of different isolators, either for protection of a system from the vibrations of the base or for the system foundation from an oscillatory force, will be discussed. The design and hardware of isolators for the fulfilment of contradictory requirements will be presented. This will include consideration of systems of variable mass, isolator inertia and isolation against very low-frequency disturbances. Finally, modelling of elastomeric and smart isolators will be explained with experimental results.

Passive Control of Structures with Tuned Dampers - Prof. Aparna (Dey) Ghosh

The principles of the vibration neutralizer through tuning will be explained. Various types of tuned dampers, namely the Tuned Mass Damper (TMD) and the different Tuned Liquid Dampers (TLDs), such as the sloshing tank damper, the Liquid Column Damper (LCD) and the Liquid Column Vibration Absorber (LCVA) will be presented. Modelling aspects and different configurations to suit specific conditions of applicability of these dampers will be discussed. Some case studies on vibration control of structures using these techniques will be presented.

Control of Time-varying Systems – Prof. Biswajit Basu

Some new approaches for control of time-varying systems will be presented. A number of methods for controlling of time-varying systems have been developed recently. These are active and semi-active approaches based on wavelet transform and time-frequency analysis. The use of wavelet and time-frequency approaches could lead to different classes of controllers such as multi-scale (system level) controllers or controllers based on signal level analysis. These types of controllers are suitable for application to time-varying systems. Further, a class of model predictive controller for robust control of time-varying systems will also be discussed. Some applications such as vibration control of wind turbines, seismically excited structures and structures interacting with the soil medium will be presented. Results from structural vibration suppression using semi-active mass and liquid dampers will also be discussed.

Bio-sketch of the speakers:

Asok Kumar Mallik is currently an Honorary Distinguished Professor at Indian Institute of Engineering Science and Technology, Shibpur. He did his Bachelor's and Masters' degrees from an earlier incarnation of the same institute in 1967 and 1969, respectively. He has taught at IIT Delhi and IIT Kanpur. He was a commonwealth scholar at The Institute of Sound and Vibration Research at Southampton, England and an Alexander von Humboldt Fellow at TH Aachen and TU Darmstadt, Germany. He is a recipient of the Distinguished Teacher Award of IIT Kanpur, Indian National Science Academy Teacher Award and Distinguished Alumnus Award of BESUS (Former Bengal Engineering College, Shibpur). He is an elected fellow of Indian National Academy of Engineering (FNAE), National Academy of Sciences, Allahabad, (FNASc), Indian Academy of Sciences, Bangalore (FASc) and The Indian National Science Academy, New Delhi (FNA). He is an Honorary Fellow of The Association of Mechanisms and Machines for his life-time contribution in the field of Theory of Mechanisms and Machines. Besides contributing a couple of book-chapters, he has authored/coauthored 9 books and more than 85 research papers in International Journals. Areas of his research include Vibration Engineering, Nonlinear Dynamics and Kinematics. He also writes articles and books on Mathematics and Physics at a popular level.

Aparna (Dey) Ghosh is presently Professor of Civil Engineering at the Indian Institute of Engineering Science and Technology, Shibpur. Her chief areas of work are structural dynamics, vibration control and earthquake engineering. She is a gold medallist from Jadavpur University (1993) and has obtained her M.Tech degree in Structural Engineering from IIT, Kanpur (1996) and Ph.D. from Jadavpur University (2004). She has also worked in the industry in M. N. Dastur & Co. (P) Ltd. and in Development Consultants Pvt. Ltd. She has carried out several research projects on tuned dampers with DST and BARC. She has won awards such as the Young Faculty Research Award by the Bengal Engineering College Alumni Association of Washington DC Metropolitan Area and the Department of Atomic Energy, Govt. of India, Research Award. She has over forty publications in international journals and international conference proceedings.

Biswajit Basu is a Professor in the School of Engineering, Trinity College Dublin. He has been a Visiting Professor at Rice University USA, a Guest Professor at Aalborg University Denmark. He received his Bachelors from Jadavpur University, India, and Masters and PhD from Indian Institute of Technology Kanpur in 1992, 1994 and 1998 respectively. His research expertise is in the area of non-stationary analysis of structural systems, system identification and structural control on which he has extensively published. Application areas involve: vibration and optimal power control of renewable energy devices like offshore wind turbines and wave energy converters; wind and earthquake engineering, and traffic flow dynamics. In addition, he has worked and published in the areas of self-healing structures, smart dampers, game theory based renewable energy policy and, controllers and fault detection in energy efficient buildings. Among other areas his current research focuses on SmartCities. He has published over 220 peer reviewed papers of which over 120 are in internationally reputed journals. He has supervised 21 PhD and 5 Post-doctoral researchers. He is an Editor/Associate Editor of seven journals including ASCE Structural Engineering, IEEE Sustainable Energy. He has collaborated with a number of industries such as Plaxis BV, Integrated Environmental Solutions, Henkel Ireland, DNV GL GH, Ramboll, D2S International, Swirl, ESRI. He became a Fellow of Trinity College Dublin in 2006, received the EU FP7 research champion award from the President of Ireland in 2012 and was nominated to High-End Foreign Expert Program in China in 2015.