ME Seminar

Computation of Natural Frequencies and Mode Shapes of One Dimensional Continuous Structures with Arbitrary Nonuniformities, Discontinuities and Constraints

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ABSTRACT

One dimensional continuous structures include longitudinal vibration of bars, torsional vibration of shafts, and transverse vibration of beams. For uniform one-dimensional structures, there are analytical solutions. However, many engineering structures are not uniform and they can also be spatially discontinuous. In general, natural frequencies and mode shapes for these nonuniform structures are computed by approximate techniques such as Rayleigh-Ritz, Galerkin, finite element and transfer matrix methods. In this talk, a new method will be presented to compute natural frequencies and mode shapes of an one dimensional continuous structure with arbitrary nonuniformities, discontinuities and constraints. The method is based on the computation of spatial state transition matrix, which is independent of boundary conditions. Then, the equations for computing natural frequencies and mode shapes are developed in terms of the state transition matrix for any boundary conditions. The method can be described as “almost closed-form solution” in this digital age. The method will be illustrated via many examples: longitudinal vibration of rectangular bars, torsional vibration of circular shafts, Euler-Bernoulli beam, axially moving beams, flutter of one dimensional panel, Timoshenko beams , and fundamental partial differential equation for mistuned bladed disk vibration.

ABOUT THE SPEAKER

Alok Sinha is a Professor of Mechanical Engineering at The Pennsylvania State University, University Park, He received his B. Tech. and Ph.D degrees in Mechanical Engineering from IIT Delhi and Carnegie Mellon University, Pittsburgh, respectively. His areas of teaching and research are Vibration, Control Systems, Jet Engines, Robotics, Neural Networks and Nanotechnology. He has authored a graduate textbook “Linear Systems: Optimal and Robust Control” (CRC Press) , an undergraduate textbook “Vibration of Mechanical Systems” (Cambridge University Press) and a research monograph , “Vibrations of Nearly Periodic Structures and Mistuned Bladed Rotors” (Cambridge University, Press). He has served as a Visiting faculty of Aeronautics and Astronautics at MIT, Cambridge and Stanford University; and as a researcher at Pratt & Whitney, E. Hartford, CT. He has also been associate editors of ASME Journal of Dynamic Systems, Measurement and Control, ASME Journal of Turbomachinery and AIAA Journal. He currently serves as an Associate Editor of Journal of Vibration Engineering and Technologies. Alok Sinha is a Fellow of ASME, a Fellow of American Association for the Advancement of Science (AAAS) , and an Associate Fellow of AIAA. He has received NASA certificate of recognition for significant contribution to Space Shuttle Microgravity Mission.

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