

dynamic range are also analyzed. The effects of the above instrumentation errors on the optimization problem associated with experimental modal analysis are also explored as well as the potential benefits that an enhanced frequency response matrix estimate, as a result of the above system identification process, can provide.

3:15

O5. Modal analysis of rotating machinery. S. P. Ying (Gilbert Services, Inc., P.O. Box 1498, Reading, PA 19603)

Modal analysis of rotating machinery and its supporting structure is discussed. This paper presents the natural frequencies, damping ratios, and mode shapes of various modes of rotating machinery systems such as fans and radar antenna foundations as examples. For a rotating machinery, it is necessary to have a dynamic correction factor for the dynamic natural frequency of a rotor (critical speed). The dynamic correction factor for ventilation fans is presented with examples. The overall natural frequency of an entire system depends on the dynamic combination of the rotor and its supporting structure. If a heavy duty rotor bearing is used, the mode for the rotor having a rigid support becomes significant, which simplifies design, and the dynamic sensitivity of the system is reduced. For a large industrial fan, an early foundation design is compared with an improved foundation design in later stage from a mode shape viewpoint. Based on suggestions developed from modal analyses, a supporting structure was improved, gear noise resulting from torsional vibration was eliminated, and a rotor resonant problem was resolved.

Contributed Papers

3:40

O6. Group delay and reverberation in multi degree of freedom systems. Djamil Boulahbal and Richard H. Lyon (Department of Mechanical Engineering, MIT, Cambridge, MA 02139)

Signals that travel in multi degree of freedom (dof) systems experience group delay that is a function of system geometry, modal density, damping, and signal processing procedures. This paper is interested in developing inverse filters for such systems for the purposes of mechanism and structural diagnostics, and the dereverberation of response signals. The design of inverse filters is greatly aided if the process can begin with approximations to the system transfer functions that are based (at least in part) on conceptual models for the system dynamics. In this paper, the theoretical basis for such models is outlined, including the effects of signal processing procedures. The various elements of these models that have been tested experimentally, and the results of these studies will be presented.

3:55

O7. Resonance characteristics of connected subsystems. Takeru Igusa, Jan D. Achenbach, and Kyung-Won Min (Department of Civil Engineering, Northwestern University, Evanston, IL 60208)

Resonance characteristics of a collection of linear subsystems interconnected by waveguides is examined. The properties of the subsystems are determined separately using modal or mobility analysis, and the topology of the waveguide network is cast in matrix form using a wave propagation approach. It is found that harmonic responses are described by multi-valued analytic functions defined in the complex plane (or a single-valued function on a Riemann surface). The excitation frequency is represented by the unit circle and resonances are poles located outside of the circle. The analytic form of the response functions provide insight into the relationships between the modes of each interconnected subsystem as well as the relationship between modal vibration and wave propagation effects. These relations are complicated by the fact that the interconnecting waveguides by themselves introduce new modes of vibration. The complexity of the problem is reduced by restricting the analysis to a window of complex frequencies, whose width is determined by the degree of interaction between modes of the subsystems and wave guides. The interaction is measured by parameters generalized from an earlier study of simpler subsystems [T. Igusa and A. Der Kiureghian, *J. Eng. Mech.* **101**, 20-41 (1985)]. [Work supported by ONR.]

4:10

O8. Detection of global modes in a foundation and hull structural model from drive point mobility measurements on the foundation. Kevin McCoy and Richard H. Lyon (Departments of Ocean and Mechanical Engineering, MIT, Cambridge, MA 02139)

Closely coupled modes of two connected structures may be considered to be "global modes," involving the combined motion of both structures. Such modes will account for the greatest energy transfer between the structures, and it is therefore desirable to find ways of detecting them. This paper is interested in the case in which it is convenient to make measurements on only one of the two structures, in this case a "foundation model" that is connected to a "hull model." The foundation (a beam) is excited by a shaker, and its drive point mobility is measured. At certain frequencies, an interaction with the hull (plate) modes can be detected. This interaction can be modified by using small masses to change the coupling between the structures and the foundation resonances. In this way, the global modes can be separated truly from structural resonances that simply happen to lie close to each other.

4:25

O9. A generalized approach to random noise synthesis. Keng D. Hsueh and Roger P. Hamernik (Auditory Research Laboratory, 107 Beaumont Hall, State University of New York, Plattsburgh, NY 12901)

A generalized approach to the synthesis of Gaussian and non-Gaussian random noises having a preselected amplitude spectrum has been developed. An application of the inverse discrete Fourier transform following certain manipulations in the frequency domain allows both Gaussian (skewness = 0 and kurtosis = 3) and non-Gaussian (variable skewness, kurtosis, and crest factor) random noises to be constructed. The theoretical background and the results of a numerical simulation will be presented, which demonstrate the functional relation between the various spectral manipulations and the descriptors of the synthesized random noise. Analog signals were synthesized using the above method in conjunction with PC-based instrumentation. The results show that the approach is viable and that the synthesized random waveforms can be easily tailored to simulate a variety of real-world noise/vibration signals, e.g., high kurtosis (impulsive) industrial noises, helicopter noises, and missile vibration signals. The application of such a methodology to acoustical testing, environmental stress screening, structural testing, etc., will be discussed. [Work supported by NIOSH.]