2:30

2pSA3. A method to measure the equivalent acoustic impedance of a scatterer. Seung-ha Lee (Ctr. for Noise and Vib. Control, Dept., of Mech. Eng., KAIST, Sci. Town, Daejeon, 305-701, Korea, seung-habird@kaist.ac.kr)

The procedures of simplifying scatterers' geometry and finding its equivalent acoustic impedance are proposed by using scattering holography and multiple multipole expansions. The scattered sound field depends on the incident field, the geometry, and the physical property of the scatterer, which can be measured by using tools such as a set of microphones and a 3-D scanner. Once the sound field over a surface is measured, the whole sound field of 3-D space can be reconstructed by acoustic holography. However, predicting near-field sound by holography is inefficient in practice, because huge numbers of measurement points are required to describe the complex sound field in the vicinity of a scatterer. With this regard, multiple multipole expansions are employed to reduce the number and the size of elements of a scatterer necessary to express the measured scattered field. Therefore it is equivalent to simplifying the geometry of a scatterer, and enables us to predict the sound pressure and velocity, as well as acoustic impedance, on the scatterers' surface. Using the proposed method, it is demonstrated that the equivalent acoustic impedance can be obtained. [Work supported by the BK21 project initiated by the Ministry of Education and Human Resources Development of Korea.]

2:45

2pSA4. Acoustic backscattering from fluid-filled submerged prolate spheroidal shells. Jeffrey E. Boisvert (NAVSEA Newport, Newport, RI 02841) and Sabih I. Hayek (Penn State Univ., University Park, PA 16802)

The equations of motion for nonaxisymmetric vibration of prolate spheroidal shells of constant thickness were derived using Hamilton's principle [S. I. Hayek and J. E. Boisvert, J. Acoust. Soc. Am. **114**, 2799–2811 (2003)]. The shell theory used in this derivation includes shear deformations and rotatory inertias. The shell displacements and rotations were expanded in infinite series of comparison functions. These include associated Legendre functions in terms of the prolate spheroidal angular coordinate and circular functions in the azimuthal angle coordinate. The fluid-filled shell is insonified by a plane wave with an arbitrary angle of incidence. The external and internal fluid loading impedances were computed using an eigenfunction expansion of prolate spheroidal wavefunctions. Far-field backscattered acoustic pressure spectra are presented as a function of the angle of incidence for several shell thickness-to-half-length ratios ranging from 0.005 to 0.1, and for various shape parameters, a, ranging from an elongated spheroidal shell ($a=1.01$) to a spherical shell ($a\sim 100$). A comparison of the backscattering from fluid-filled and empty shells is presented at selected plane wave incident angles. [Work supported by the ONR/ASEE Summer Faculty Research Program and the NAVSEA Newport ILIR Program.]

3:00

2pSA5. Modeling a magnetorheological elastomer's transient stiffness parameters. Anne-Marie Lerner and Ken Cunefare (Georgia Tech., ken.cunefare@me.gatech.edu)

Semiactive vibration absorbers are tunable vibration absorbers whose natural frequencies can change controllably to minimize vibration better than their passive counterparts, which can be used to reduce occupant vibration in cars. The variable natural frequency is achieved by using a dynamically tunable spring. In order to use a material as a dynamically tunable spring, its transient parameters must be understood and controlled, so as not to lead to instability. This work characterizes the behavior of magnetorheological elastomers (MREs), which are a type of ferromagnetic-elastomer composites whose tensile/compressional stiffness increases as an applied magnetic field is increased. If the transition from one stiffness state to another is too slow, the MRE can have a detrimental effect on vibration control. Transient behavior of MREs with different concentrations of ferromagnetic material and different geometric shapes was recorded empirically, and the MRE stiffness change in response to a change in magnetic field was modeled as a function of ferromagnetic content, MRE geometric shape, and the change in magnetic field strength. MREs in this configuration exhibited natural frequencies in the 30–65-Hz range, where MREs were able to change their natural frequency by up to 17%.

3:15–3:30 Break

3:30

2pSA6. Vibration absorption by an undamped beam element. Ilker Murat Koc, Adnan Akay (Dept. of Mech. Eng., Carnegie Mellon Univ., Pittsburgh, PA 15213), and Antonio Carcaterra (Univ. of Rome, La Sapienza, 00184, Rome, Italy)

Through two complementary approaches, using modal response and wave propagation, this presentation will show the conditions under which a decaying impulse response, or a nearly irreversible energy trapping, takes place in a linear conservative continuous system. The results show that the basic foundation of near-irreversibility or pseudo-damping rests upon the presence of singularity points in the modal density of the systems. To illustrate the concept of pseudo-damping in detail, a simple undamped beam is modified to introduce a singularity point in its modal density distribution. Simulations show that by a suitable application of a compressive axial force to an undamped beam on an elastic foundation, the impulse response of a beam shows the characteristics of a nearly irreversible energy trap and a decaying impulse response. Attaching such a modified beam to a single degree of freedom oscillator shows energy trapping by the beam producing pseudo damping. [Research carried out while AA served at NSF.]

3:45

2pSA7. Pseudo-damping in undamped plates and shells. Antonio Carcaterra (Dept. of Mech. and Aeronautics, Univ. of Rome, La Sapienza Via Eudossiana, 18, 00184, Rome, Italy) and Adnan Akay (Carnegie Mellon Univ., Pittsburgh, PA 15213)

Pseudo-damping is a counter-intuitive phenomenon observed in a special class of linear structures that exhibit an impulse response characterized by a decaying amplitude, even in the absence of any dissipation mechanism. The conserved energy remains within but designated parts of the system. Pseudo-damping develops when the natural frequency distribution of the system includes condensation points. The recently formulated theoretical foundation of this phenomenon, based on mathematical properties of special trigonometric series, makes it possible to describe a class of mechanical systems capable of displaying pseudo-damping characteristics. They include systems with discrete oscillators and one-dimensional continuous beamlike structures already reported by the authors in recent studies. This paper examines development of pseudo-damping phenomenon in two-dimensional structures, using plates and shells as examples, and shows how a preloaded plate on an elastic foundation can lead to pseudo-damping. Moreover, in the case of curved shell elements examined here, pseudo-damping can result due to the curvature of the structure, which naturally introduces condensation points in the modal density. [Research carried out while AA served at NSF.]

4:00

2pSA8. Fundamentals of apparent damping phenomena in linear conservative systems. Antonio Carcaterra (Dept. of Mech. and Aeronautics, Univ. of Rome, La Sapienza Via Eudossiana, 18, 00184, Rome, Italy) and Adnan Akay (Carnegie Mellon Univ., Pittsburgh, PA 15213)

This presentation addresses a class of irreversible phenomena that can develop in linear conservative systems and provides a theoretical foundation to explain the underlying principles. Recent studies have shown that energy can be introduced to a linear system with near irreversibility, or energy within a system can migrate to a subsystem nearly irreversibly, even in the absence of dissipation. Inspired by the properties of probability distribution functions, the general formulation developed here is based on particular properties of harmonic series, which form the common basis of