mobility functions are determined for a copper pipe of radius 0.025 m and wall thickness 1.5 mm. For the input mobility functions, the nearfield effects combine with the coriolis effects of the moving fluid to produce instabilities of the circumferential modes at velocities that depend upon the mode number. For the transfer mobility functions, broadband peaks appear caused by the phase lag between waves of different circumferential mode numbers. These peaks are shifted and modified as the flow speed changes.

9:05

HH3. Response of a fluid-filled spherical shell submerged in an infinite fluid medium to a transient acoustic wave. Thomas L. Geers and Peizhen Zhang (Department of Mechanical Engineering, University of Colorado, Boulder, CO 80309)

Transient response problems involving fluid-filled shell structures submerged in infinite fluid media arise in various fields, including medicine, defense, and materials engineering. A canonical problem of this class possesses a spherical geometry, for which no solutions apparently exist. This paper delineates a relatively simple formulation and method of solution for this canonical problem and presents solutions for excitation by an incident step wave. The formulation begins with the familiar equations of motion for a thin spherical shell and the wave equation for the internal and external fluid domains. The Laplace transform is invoked, and the usual separation of variables method yields modal expressions involving Legendre polynomials and modified spherical Bessel functions. The explicit expressions for the latter are then manipulated to yield, after transform inversion, delayed differential equations in time for each response mode of the shell–fluid system, which are integrated numerically in time. Complete response solutions then follow by modal superposition, with special techniques being employed to improve modal convergence. To validate the methodology, numerical results are first presented for an incident step wave exciting a shell with mass density and acoustic velocity identical to the corresponding properties characterizing the same internal and external fluid. Results are then shown for a step-wave-excited steel shell containing water and submerged in water. [Work supported by DNA.]

9:20

HH4. Active control of panel-radiated noise using multiple piezoelectric actuators. B. T. Wang, E. K. Dimitriadis, and C. R. Fuller (Department of Mechanical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061)

The potential for active control of structurally radiated nosie by two-dimensional piezoelectric patches bonded to the surface of thin elastic panels is analytically investigated. A previously presented approximate model for the loads induced by piezoelements bonded to the plate surface is employed for the calculation of the vibration and sound radiation from simply supported rectangular panels. The piezoelectric action modifies the vibration and hence effects the noise radiated by the panel when excited by constant distributed external forces. The complex amplitude of the voltage applied to the piezoelectric is estimated via an optimization scheme that minimizes the total radiated acoustic power into the farfield. Results have been obtained for a single as well as for multiple independently controlled actuators. It is seen that quite significant control is possible in some cases with a single appropriately taylored actuator. The effectiveness, however, deteriorates as control of higher vibration modes is attempted. Much better results are achieved with two or more independently controlled actuators bonded to the plate. It is clearly shown that multiple, appropriately positioned actuators drastically reduce undesired control spillover to the residual modes. [Work supported by ONR.]

9:35

HH5. Coupling effects between a lumped vibrational source of finite impedance and a plane radiator. Dominique Trentin, A. Berry, and Frederic Laville (GAUS, Mechanical Engineering, University of Sherbrooke, Sherbrooke, Quebec J1K 2R1, Canada)

A typical situation in structural acoustics and vibrations is the case of a mechanical source of vibrations attached to a large, thin structure (radiator). In general, the force input into the structure, responsible for undesired vibrations of, and radiation from, the structure, is the resultant of both the output impedance of the source and the input impedance of the structure. A theoretical analysis of the problem is presented in the case of a lumped mechanical source composed of masses, springs, and dampers, with one single attachment point to a baffled, thin, rectangular, plane structure. The coupling assumes only pure transverse force transmission into the structure. A quadrupole approach for the source assembly and a variational approach for the motion of the structure allow, respectively, the source output impedance and the structure input impedance to be calculated in a variety of configurations. The force input into the structure, kinetic energy of the structure, and radiation of sound from the structure can then be derived. It is shown how the natural frequencies of the combined system can be found from the natural frequencies of the source and structure decoupled. Numerical results are presented for the particular application of optimal suspension design of mass-type source. [Dr. I. Michaluk is acknowledged for fruitful discussions.]

9:50

HH6. Active control of flexural power flow in beams using piezoceramic actuators. Gary Gibbs and Chris Fuller (Department of Mechanical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061)

Previous research has demonstrated that the flexural power flow in thin beams can be attenuated using active point force inputs [C. R. Fuller and L. O. Gonidou, "Active vibration control of flexural power flow in beams," J. Acoust. Soc. Am. Suppl. 1 **84**, S47 (1988)]. In this paper, the results of experiments that demonstrate the feasibility of using surface-bonded piezoceramic actuators and sensors in controlling vibrational power flow in elastic structures are presented. The control system utilizes both a piezoceramic control actuator and sensor, and a time domain least-mean-squares adaptive algorithm to minimize transmitted power flow. Both semi-infinite and finite beams of various geometries are considered, and the results show significant reduction of vibrational power flow using only a single piezoceramic transducer as the control actuator. [Work supported by NASA Langley Research Center.]

10:05

HH7. Vibration and stability of an elastic beam subjected to a periodic axial load with time-dependent displacement excitation at both ends. Xiao-Feng Wu and Adnan Akay (Department of Mechanical Engineering, Wayne State University, Detroit, MI 48202)

This paper considers the vibration and stability of an elastic beam under the excitation of a combined periodic axial load and time-dependent displacement at its ends. Such problems are often encountered in the prediction of noise radiation from high-speed planar mechanisms with elastic couplers. The governing equation of motion for the vibrating beam derived by the Hamilton's principle is highly nonlinear. To obtain an approximate solution, the method of assumed modes is used. The equation of motion then reduces to a Hill type of equation in time. The parametric studies of the stability of the beam is carried out. The stable and unstable regions of the beam vibrations under the time-dependent displacement excitations are investigated. The independent restraint motions at the ends of the beam are described by the *displacement influence functions.* The total response is finally obtained by adding the relative motion of the beam under the given boundary conditions to the specified displacement at its ends.

10:20

HH8. Nonlinear effects in a driven vibrating wire. Roger J. Hanson and Hilliard K. Macomber (Physics Department, University of Northern Iowa, Cedar Falls, IA 50614-0150)