# Plates with regular stiffening in acoustic media: Vibration and radiation

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composite and layered media where compliance is dominated by one medium and density by another. Examples of this situation are: flexible conduits containing a liquid, e.g., blood vessels; bubble swarms; porous elastic solids with Poisson's ratios in excess of one-third; compliant layers in contact with a liquid, e.g., sedimentary ocean bottom containing gas bubbles or a compliantly coated structure immersed in a liquid.

**1:35**

**J2. The transient response of fluid-loaded structures using time-domain methods.** Peter R. Stepanishen (Department of Ocean Engineering, University of Rhode Island, Kingston, RI 02881-0814)

Over the past several years, time-domain methods have been developed to address the transient radiation and scattering from structures in fluids with and without a mean flow. These methods are based on using *in vacuo* modal expansions with time-dependent coefficients that are coupled due to the fluid. To date these methods have been used to investigate the transient response of baffled membranes, plates, and cylindrical shells. The development of the basic computational method will be reviewed and compared to alternative methods, e.g., the doubly asymptotic approximation. Numerical results will then be presented to illustrate typical transient phenomena of interest. A particular example of interest is the destabilizing effect of a mean flow over a vibrating surface. [Work supported by the Office of Naval Research.]

**2:05**

**J3. Measurement of flow excitation function.** Charles H. Sherman, Sung H. Ko, and Barry G. Buehler (Naval Underwater Systems Center, New London, CT 06320)

Wave vector filter measurements have been made with the objective of improving quantitative knowledge of the flow excitation function. Two hydrophone arrays with the same number of elements but different spacings were used. The more closely spaced array covers high wavenumbers characteristic of the convective region of the turbulent boundary layer pressure fluctuations, while the other array covers the lower wavenumber region where contaminants associated with the experimental arrangement also usually exist. The arrays were mounted on a damped composite plate and tested at various flow speeds. Individual hydrophone outputs from both arrays were sampled simultaneously, digitized, recorded, and spectral analyzed in frequency and two wave vector components. Results will be presented as amplitude contour plots as a function of the two wave vector components on the plane of the plate at various frequencies. Results from the closely spaced array show the shape and level of the convective ridge and give an estimate of the difference between the convective peak level and the low wavenumber domain. Results from the other array show that the low wavenumber domain also contains wave vector components associated with free plate vibrations {confirmed by calculations based on work by D. J. Mead and S. Markus [J. Sound Vib. **10**(2) (1969)]} as well as acoustic components. [Work supported by ONR.]

**2:35–2:50**

**Break**

**2:50**

**J4. Plates with regular stiffening in acoustic media: Vibration and radiation.** Denys J. Mead (Department of Aeronautics & Astronautics, University of Southampton, Southampton, England)

Flat plates and cylindrical shells with identical stiffeners at regular intervals constitute spatially periodic structures, and specially convenient methods of analysis are available for the study of their vibrations. Some of the methods are suitable for the inclusion of the effects of fluid loading from adjacent acoustic media. This paper outlines the nature of the free wave motion that can occur in periodic structures that are stiffened either in one direction or in two orthogonal directions. It is shown how their responses to distributed sound fields can be determined by using displacement functions consisting of a series of space harmonics or of simple assumed polynomial modes. The sound that is reradiated or transmitted by the structure is also found. Methods that have been developed for analyzing the response and radiation due to line or point forces are reviewed. Recent developments in the analysis of periodically stiffened cylindrical shells are described. The hierarchical finite element method has been applied to determine flexural wave speeds in both flat reinforced plates and in reinforced cylinders. Symbolic computing has been used to set up the relevant stiffness and mass matrices. Some computed results are presented.

**3:20**

**J5. Control of sound radiation from submerged plates.** Leonard Meirovitch and Surot Thangjitham (Department of Engineering Science and Mechanics, Virginia Polytechnic Institute & State University, Blacksburg, VA 24061)

The subject of sound radiation from submerged elastic bodies, and in particular flat plates, is our current research interest in the field of underwater acoustics. Because the plate is in contact with the surrounding fluid,