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POD-based Reduced-order Model for Forced Motion and Vortex-Induced Vibration of a Circular Cylinder ARNE J. PEARLSTEIN, RAVI KUMAR R. TUMKUR, GUY BEN-DOV[1], RAMON CALDERER, ARIF MASUD, LAWRENCE A. BERGMAN, ALEXANDER F. VAKAKIS, University of Illinois at Urbana-Champaign — For flow past a cylinder either held fixed, in prescribed harmonic motion perpendicular to the mean flow, or mounted on a linear spring and undergoing vortex-induced vibration (VIV) perpendicular to the mean flow, a finite-element method (FEM) is used to compute high-fidelity solutions of the Navier-Stokes equations at $Re = 100$ (based on diameter). By means of proper orthogonal decomposition, the computed velocity field is used to construct a set of orthogonal vector-valued velocity modes. The pressure field is decomposed into a set of nonorthogonal modes. An approximate reduced-order model (ROM) is obtained by projecting the Navier-Stokes equations onto these modes. To stabilize the resulting ordinary differential equation system, we add a "shift mode" calculated using the steady symmetric solution for a stationary cylinder. For all three cases (stationary cylinder, prescribed motion, and VIV), the ROM gives velocity and pressure fields in good agreement with the high-fidelity FEM results.

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