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Ph.D. SEMINAR TALK - 2

Title: **Energy harvesting from vortex-induced vibrations of elastically mounted single and multi-cylinders**

Speaker: **Mr Shristi Singh (ME21D025)**

Biography of the Speaker:

Ph.D. Research Scholar for the Dept of Mechanical Engineering, IITM

Date and time: **29-01-2026 at 3:00 PM**

Venue: **https://meet.google.com/ywx-bjwr-dap**

Abstract

Vortex-induced vibration (VIV) refers to the response of an elastically mounted body subjected to fluid flow, in terms of structural oscillations (for rigid bodies) and/or deformations (for elastic bodies). It has attracted significant amount of research interest due to its exciting flow physics and wide applications in many fields of engineering, such as marine engineering (riser tubes, offshore platforms), civil engineering (buildings, bridges), thermal engineering (heat-exchanger tubes) and energy harvesting. The present study investigates VIV response of elastically mounted single and multi-cylinder arrangements, with focus on wake transition instabilities, cylinder responses and potential applications in energy harvesting. Wake instability and cylinder dynamics are investigated for a rigid circular cylinder mounted on a spring-damper system, allowed to move in both the stremwise (x) and cross-flow (y) directions (2-DOFs), with varying spring stiffness (k*) in the respective directions. Distinct wake instability modes ('Mode A', 'Mode B', and 'Mode C') are observed. In order to capture the nonlinear elastic behaviour of the structure, a nonlinear model for spring stiffness has also been developed and integrated with the CFD solver. Results reveal that nonlinear spring stiffness can increase the vibration amplitude and enhance the range of stable oscillations. Both two-dimensional (2D) and three-dimensional (3D) numerical computations are carried out to study the coupled fluid–structure interaction (FSI) problem using the open-source C++ library-based solver OpenFOAM. Mesh deformation due to cylinder motion is handled using two approaches, viz. the morphing and the overset mesh methods. Computations of multi-cylinder arrangements under different restraints and orientations reveal complex vortex interactions and their energy-harvesting potential. Computations are carried out at low value of Reynolds number (Re = 150), with a mass ratio of 2 and damping ratio (ζ) of 0.01, over a range of reduced velocity (Ur) from 1 to 15. In the multi-cylinder arrangement, wake-induced vibrations generally occur with high amplitude for the cylinder located in the wake of the others. The dynamic response is further analyzed using time series, phase portraits, and Poincare maps. Hilbert Huang transformation (HHT) is used to decompose complex, nonlinear and nonstationary time signals into different components of varying frequency and amplitude over time.