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臺灣大學應用力學研究所
演 講 公 告

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講 題：Mode Transformation and Interaction in Vortex-Induced Vibration of Laminar Flow Past a Circular Cylinder

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時 間： 111年9月2日（星期五）上午10時開始

地 點： 臺灣大學應用力學研究所 402 會議室

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Mode Transformation and Interaction in Vortex-Induced Vibration of Laminar Flow Past a Circular Cylinder

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An investigation of the mode transformation and interaction underlying the behavior of vortex-induced vibration (VIV) of a flow past a circular cylinder elastically mounted on a linear spring is conducted using a high-fidelity full-order model (FOM) based on computational fluid dynamics (CFD), a reduced-order model (ROM), and a dynamic mode decomposition (DMD) of the velocity. A reduced-order model for the fluid dynamics is obtained using the eigensystem realization algorithm (ERA), which is subsequently coupled to a linear structural equation to provide a state space model for the coupled VIV system, in order to provide a simplified computationally inexpensive mathematical representation of the system. This methodology is used to study the dynamics of laminar flows past an elastically mounted circular cylinder with Reynolds numbers ranging from 20 to 180, inclusive. The results of the simulations conducted using FOM/CFD and ROM/ERA, in conjunction with the power spectral analysis and DMD, are used to identify the characteristic natural frequencies and the growth/decay of various modes (including the complex interactions between the myriad wake modes and the structural mode) of the VIV system as a function of the Reynolds number and the reduced natural frequency (or, equivalently, the reduced velocity). A detailed analysis of the distribution of the eigenvalues of the transfer (or, system) matrix of the reduced VIV system shows that the frequency range of the lock-in can be partitioned into resonance and flutter lock-in regimes. With increasing Reynolds number, the instability of each wake mode is enhanced resulting in a transformation of the wake modes interacting with the structural mode.