FDRG Seminar

Energy harvesting of spring-mounted lifting plates in axial- and cross-flows

presented by

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The presentation will be in two parts that will summarise the work on this topic that has been conducted in the department since 2011. Each part was a separate presentation at the FSSIC 2015 last year on our computational work. However, the presentations will also be interspersed with details of our experimental work carried out by several of our past and present 4th year project students.

1. Two different linear spring-mounting systems of lifting flexible plates in ideal flow are compared for their suitability in energy harvesting of induced flutter instability via the reciprocating motion of the spring system. In previous work, it was found that compared to a fixed cantilever the introduction of the dynamic support in both systems yields lower flutter-onset flow speeds which is desirable for energy harvesting applications. The first system is a cantilevered thin flexible plate aligned with a uniform flow with the upstream end of the plate attached to a spring-mass system. We compare this system to one where the upstream end is hinged with a rotational spring at the mount. We map out the linear stability and power output characteristics of both systems with the introduction of dashpot damping at the mount. As expected the introduction of damping stabilises both systems and the order of magnitude of this stabilisation varies non-linearly for different levels of damping; this results in optimal points for energy harvesting for each system.

2. Non-linear fluid-structure interactions will also provide a useful source of energy to be harvested. A new model is presented of the nonlinear fluid-structure interaction of a cantilevered flexible plate with an ideal flow that can account for the effect of boundary-layer separation from the plate surface upstream of its trailing edge. The model also allows for the wake to be formed solely from the trailing edge, an assumption used in previous studies of the system that also constrain the path of its lumped vorticity thereby precluding roll-up. Short plates are studied herein for which the behaviour is dominated by low-order structural modes. When the wake is forced to form from the trailing edge the typical sequence of amplitude growth to nonlinearly saturated oscillations at flow speeds above that of the onset of linear instability is found. However, if separation is included the system evidences the same sequence at a flow speed for which the system is neutrally stable to linear disturbances. This suggests that flow separation may be the cause of the sub-critical instability found in experimental studies of the system. The mechanism for this effect is briefly discussed though a consideration of the wake dynamics.

Date: Friday 18th March
Time: 4pm – 5pm
Location: 204:505
Curtin University, Bentley Campus

No RSVP required. For queries please email:
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