ME5B01 Flow-Induced Vibration [5 Credits]

Lecturers: Associate Professor Craig Meskell (cmeskell@tcd.ie)

Module organisation
Prerequisite Course(s): Foundation course in aerodynamics (ME4B13); and fundamentals of dynamics and vibrations (e.g. ME3B5) or equivalent

Module description, aims and contribution to programme
A large engineering structure which experiences a fluid flowing across it may be prone to flow-induced vibration. This apparently “self-excited” motion may be large amplitude and also may ultimately lead to catastrophic failure. Examples of systems that exhibit this type of behaviour are:

- aircraft lifting surfaces;
- wind, gas and steam turbines;
- tall slender buildings;
- suspension bridges decks;
- arrays of marine risers;
- heat exchangers tube arrays;
- flow control valves.

In these cases, flow-induced vibration may represents a design constrain and/or an operational constraint, with consequent compromise of system performance. This course will introduce the student to problems in aeroelasticity and flow-induced vibration.

Learning outcomes
On successful completion of this course, students will be able to:
1. Explain the problems that coupling with a fluid (both quiescent and flowing) can pose for structural mechanics;
2. Report on the current state-of-the-art in the area of FIV;
3. Classify the mechanisms for flow-induced vibration and explain the qualitative differences between these mechanisms;
4. Analyse theoretically single and multi-degree of freedom aeroelastic systems;
5. Apply CFD simulations to determine the behaviour of a structure to flow-induced vibration.
6. Assess the impact of FIV to a particular problem.

Module content
- Classification of flow induced vibration
- Review of vibration theory, system dynamics and stability.
- Review of fluid mechanics and hydrodynamics
- Fluid Induced Vibration Mechanisms
  - Quasi-steady FIV: Galloping
  - Single degree of freedom aeroelastic instability (damping controlled)
  - Multi-degree of freedom aeroelastic instability (Stiffness controlled)
  - Vortex Induced Vibration
  - Example Applications

Teaching strategies
Flow Induced Vibration is an optional course which is offered to 5th year MAI students and Graduate Students. The course material is present as a series of seminars. The continuous assessment is in the form of a number of modelling exercises of system dynamics and galloping. Although the course is quite mathematical, real world examples and anecdotes, particularly from the aerospace and power generation industries, drawn from the lecturer’s research expertise, are used to illustrate the technical content. This helps the student to contextualize the details of the course in an engineering light.

**Assessment**
Exam (50%) and assignments (50%).

**Required textbook**

**Additional Reading:**