COURSE OF THE XVIII SPANISH-FRENCH SCHOOL *Jacques-Louis Lions*
ABOUT NUMERICAL SIMULATION IN PHYSICS AND ENGINEERING
Las Palmas de Gran Canaria, June 25-29, 2018

Aeroelasticity and Dynamical Systems

Philippe Destuynder*

1 Outline of the course

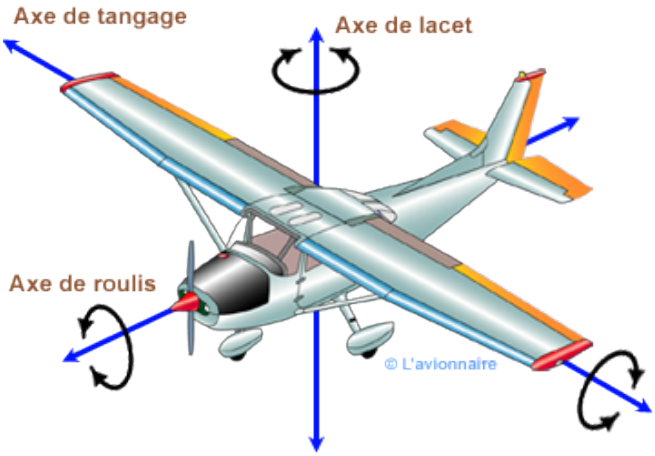
The goal of this short course is to point out few phenomenae occuring in aeroelasticity and to discuss their mathematical modelling. The framework is the quasi-static approximation in subsonic flows. Thus the aerodynamical forces are deduced from static wind tunnel tests or from stationary computations. In other words, it means that forces due to the flow are only dependent on the relative configuration of the structure with respect to the wind velocity. This is an assumption which is valid as soon as the relative velocity of the structure is much smaller than the one of the main flow (in a wind tunnel) or of the translation velocity (for a flying item).

Several mechanical instabilities are explained from the physical point of view and simple but realistic models are presented and analyzed. The mathematical tools used are the dynamical system theory and the reduction method for flexible linearly elastic structures.

After a brief presentation of wind tunnel technologies, the course gives a description of Strouhal instabilities for low Reynolds numbers leading to Von Karman paths, of the stall flutter which is responsible of the Tacoma narrow collapse, of the coupled flutter which is responsible of several plane crashes and of the buffting of rear wings.

In each case, the instability is detected from a linearized model around a given configuration and the possibility of a limit cycle of oscillation is discussed using the dynamical system theory (normal form) from the non linear formulation. Finally, two examples will be presented: one is a reduced model of a military aircraft tested in a wind tunnel and the other one concerns a flying boat with foils as those used in the recent America's cup.

Website:
http://mathserv2.cnam.fr/~wilk/Web2-mathjax/



*Département Ingénierie Mathématique (IMATH), Conservatoire National des Arts et Métiers, Paris (FRANCE). Email: phdestuynder@gmail.com