PAE - Perspectivas em Aeronáutica e Espaço

1º WORKSHOP IEEE UFSM

10 de Junho de 2016

MINI CURSO: Modeling, Simulation and Control of Airplanes

Horário: 14:00h-18:00h

Presenter:

Prof. Dr. André Luís da Silva

Objective

To introduce basic concepts and examples of flight mechanics and airplane flight control.

Specific Objectives

- To present the main concepts of rigid body mechanics applied to airplanes;
- To introduce a basic aerodynamic model;
- To show some basic feedback flight control laws;
- To perform simulations of open and closed loop airplanes.

Material

- Flight mechanics textbooks: (Stevens and Lewis, 1993) and (Roskam, 1995);
- Slides of the classes;
- MATLAB programs;
- Manuals of the programs and papers.

Workshop Program

- Basic definitions and concepts: reference frames, dynamics and kinematics, rotation and translational motion;
- Airplane basic flight commands: elevator, aileron, rudder;
- Rigid body flight model with 6 degrees of freedom (6 DOF);
- Basic aerodynamic model (stability derivatives and control derivatives);
- Trim and equilibrium;
- Longitudinal and lateral directional flight modes;
- Basic longitudinal control laws:
    - Pitch damper;
    - Pitch control augmentation;
    - Longitudinal autopilot: speed and altitude;
- Basic lateral directional control laws:

- Roll damper;
- Yaw damper;
- Wing leveler autopilot.

Method

All the concepts will be presented concisely with slides in data show with references for further study.

The concepts will be submitted to practice using a flight model of rigid airplane.

The aircraft model is obtained from (da Silva, Paglione, Yoneyama, 2010). There, the airplane is flexible, but a simple approximation is performed to obtain a rigid body model.

The aircraft basic flight controls laws can be seen in the textbooks (Stevens and Lewis, 1993) and (Roskam, 1995). They are applied to the airplane model in question in the references (da Silva, Paglione, Yoneyama, 2012) and (da Silva, Yoneyama, Paglione, 2013).

Time Schedule

The workshop will be developed in 4 hours. The will be an interval of 15 minutes for coffee break.

References

STEVENS, B. L.; LEWIS, F. L. **Aircraft Control and Simulation**. [S.l.]: John Wiley and Sons Ltd., 1992

ROSKAM, J. **Airplane Flight Dynamics and Automatic Flight Controls**, Parts 1 and 2, DARcorporation, 1995.

da SILVA, André Luís; PAGLIONE, P.; YONEYAMA, T. **Conceptual Flexible Aircraft Model for Modeling, Analysis and Control Studies.** In: AIAA Atmospheric Flight Mechanics Conference, 2010, Toronto - Canada. Proceedings of the AIAA Atmospheric Flight Mechanics Conference, 2010.

da SILVA, A.L.; PAGLIONE, P.; YONEYAMA, T. **Cruising Autopilot for a Flexible Aircraft with Internal Loop of Model Following.** Journal of Aerospace Engineering, v. 27, p. 202-214, 2012.

DA SILVA, A.L.; YONEYAMA, T. ; Paglione, P. **Optimal linear quadratic model following with application to a flexible aircraft. Journal of Vibration and Control**, v. 20, p. 1796-1815, 2013.