AE 649A: AUTOMATIC CONTROL OF AIRCRAFT, ROCKETS AND SPACECRAFT

Instructor: Dr. Dipak Kumar Giri
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Class Room : NWTF class room.
Class Time: M (NWTF) Th (NWTF) 14:00-15:15

Course Module Objectives:

The Objective of this course is to apply knowledge of mathematics and engineering to analyze and design a control system to meet desired specifications. Students should learn to analytically determine a control system's functionality and select appropriate tests to demonstrate system's performance and finally desgin a control system to meet a set of requirements. Develop an understanding of the elements of classical control theory as applied to the control of aircraft, rockets and spacecraft. In particular understand: the concept of feedback controls and its properties; the concept of stability and stability margins; feedback controllers desgin including pole-placement, LQR, Observers, and LQG; digital control approach; rigid body dynamics; spacecraft dynamics and control incldung active and passive actuators models and their control issues through feedback controls. Finally gain knowledge of the basic linear design techniques.

assignment: aug-29th Sep-26 Oct-24

Course Outline:

1. Basic Control System Concepts, different type systems
2. function of physical systems and transient response
3. Frequency response – Nyquist and Bode plots, phase and gain margins, robustness analysis
4. Automatic control- terminal and tracking controls
5. Solution of linear systems
6. Single Variable control design
7. Multivariable control design- Regulator design, pole-placement control, LQR control, Kalman Filter for LTI Systems, Control, Full and reduced order observer, and design of these controllers for longitudinal dynamics in Matlab.
8. Digital control and stability analysis
9. Rigid-body dynamics
10. Attitude Kinematics, Quaternion, Optimal spacecraft attitude control
11. Attitude Stabilization of Spacecraft, Reaction Wheel Control Systems,Magnetic Torquer/Reaction Wheel Control Systems, Control Moment Gyroscopes ,Variable Speed Control Moment Gyroscopes,
12. 1st and 2nd order dynamics of spacecraft motion dynamics, and frequency response
13. Feedback controls for attitude control of spacecraft

References/Text Books:

1. Ogata, K., Modern Control Engineering, Prentice Hall India Learning Private Limited; 5th edition, 2010
2. Tewari, A. , Modern Control Design with MATLAB and Simulink, John Wiley & Sons,Chichester, 2002.
3. Tewari, A., Atmospheric and Space Flight Dynamics, Springer (Birkhauser), Boston,2006.
4. MIT Courseware: https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-06-principles-of-automatic-control-fall-2012/readings/

Course Projects:

Modeling and designing control systems for attitude control of a spacecraft. Projects will be carried out and written up in two gropus- different controls (will be decided later). The report can be communicated to leading conferences or journals.

Marks Distribution:

Home Assignments: ~~21 (3*7)~~ 20%.
Project: 30%.
Attendance: ~~X~~ 10%.
~~Final: 40~~
END TERM : 25%.
MID TERM : 15%.