ECE 7859: Sliding Mode Control in Electromechanical Systems

Course Description

Sliding modes an efficient tool to control high order dynamic plants operating under uncertainty conditions.

Prior Course Number: 859
Transcript Abbreviation: Sliding Mode Cntrl
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Graduate
Student Ranks: Doctoral
Course Offerings: Spring
Flex Scheduled Course: Never
Course Frequency: Odd Years
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec, 3.0 hr Rec
Expected out-of-class hours per week: 3.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: 5750 (750) or MechEng 5372.
Exclusions: Not open to students with credit for 859 or MechEng 7259 or 859.
Cross-Listings: Cross-listed in MechEng 7259.

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001
Subsidy Level: Doctoral Course

Course Goals

Demonstrate the beneficial properties of sliding mode control which enables separation of the overall system motion into independent partial components of lower dimensions and low sensitivity to plant parameter variations and disturbances
Sliding mode control studies span heterogeneous problems (mathematical methods, design principles, applications). Major attention will be paid to sliding mode control design for finite-dimensional systems, governed by ordinary differential equations
The wide range of applications are demonstrated to show the advantages of the sliding mode control methodology (e.g. for electric motors, manipulators, mobile robots)
Overcome implementation difficulties, special attention will be paid to suppression of chattering caused by unmodeled dynamics

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Examples of dynamic systems with sliding modes. Sliding modes in relay and variable structure systems	3.0							

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Mathematical background: differential equations with discontinuous right-hand sides, regularization methods, equivalent control method, sliding mode existence conditions	6.0							
Design methods: decomposition, regular form of motion equations, eigenvalue placement and mean-square optimization in linear systems, control under uncertainty condition	6.0							
Chattering problem: systems with unmodeled dynamics, motion separation in singularly perturbed systems, sliding mode in systems with observers, harmonic cancellation	6.0							
Discrete-time sliding mode control: definitions, design methods, control in linear systems	5.0							
Control in distributed systems: motion equations, distributed control, modal control, point-wise control	4.0							
Control of electric motors and power converters: motion equations; speed, position, current and flux control; speed, acceleration, load torque and flux observers; DC/DC, DC/AC converters	6.0							
Control of manipulators: motion equations, position and speed control, lumped control of flexible longitudinal and rotational oscillations, control of mobile robots	3.0							
Motion equations: artificial potential field method for navigation and control, nonholonomic mobile robots	3.0							

Representative Assignments

Home works, midterms and finals are assigned by the instructor.

Grades

Aspect	Percent
Homework	30%
Midterm Exam	30%
Final Exam	40%

Representative Textbooks and Other Course Materials

Title	Author
Sliding Modes in Control in Electromechanical Systems	V. Utkin, Yu. Guldner, and J. Shi,

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	a	An ability to apply knowledge of mathematics, science, and engineering.
	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
*	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
**	e	An ability to identify, formulate, and solve engineering problems.

Course Contribution		College Outcome
	f	An understanding of professional and ethical responsibility.
	g	An ability to communicate effectively.
**	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
	i	A recognition of the need for, and an ability to engage in life-long learning.
	j	A knowledge of contemporary issues.
*	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Additional Notes or Comments

Updated course title, abbreviation, prereqs, exclusions, goals and topics to conform to university format 3/29/12

Added MECHENG 5372 (762 and 7643) to possible prereqs, added MECHENG 7259 to exclusions, added crosslinsting with MECHENG 7259 8/21/13

emove MECHENG 762 and 764 from preqs to match ME.

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