

ABET COURSE SYLLABUS

ECSE-4460 Control Systems Design

Course Catalog Description:	A capstone design course. Design principles include conceptual system design, components selection, modeling and simulation using computer-aided control design tools, and real-time programming. Each team will propose, design, evaluate, build, and test a working control system.
Pre-Requisite Courses:	Prerequisite: ECSE-4510 or ECSE-4440.
Co-Requisite Courses:	Senior Standing. ENGR-4010 Professional Development III
Prerequisites by Topic:	<ol style="list-style-type: none">1. Description of linear time invariant systems (transfer function, state space, convolution integral)2. LTI control design techniques: root locus, frequency domain, Nyquist plot, state space methods3. Physical modeling: statics, friction4. Differential equation5. Design and analysis tool: MATLAB and Simulink
Textbook & Materials:	<ol style="list-style-type: none">1. <i>Engineering Design for Electrical Engineers</i> Alan D. Wilcox (recommended)2. Quadrille Cloth-Bound Laboratory Notebook (required)
References:	<ol style="list-style-type: none">1. Ogata, <i>Modern Control Engineering</i>, Prentice-Hall, 2002, 4th Edition2. Franklin, Powell, and Emami-Naeini, <i>Feedback Control of Dynamical Systems</i>, Addison-Wesley, 1990, 3rd Edition.3. Frederick and Chow, <i>Feedback Control Problems using MATLAB & Control System Toolbox</i>, PWS Publishing, 1995.4. Leonard and Levine: <i>Using MATLAB to Analyze and Design Control Systems</i> (2nd Ed.), Benjamin/Cummings Publishing, 1995.5. Course web site (www.cats.rpi.edu/ECSE4660S06)
Course Coordinator:	John T. Wen
Overall Educational Objective:	The course goal is to provide a team-based, practical, culminating (“capstone”) experience in control systems design. The control system design principles include conceptual system design, components selection, modeling and simulation using computer-aided control design tools, and real-time programming. The ability to work in teams, and to effectively convey technical results, both by oral presentation and written communication is emphasized. Each team will propose, present, design, evaluate, and test a working control system. Evaluation of each team's performance is based on individual contribution, intermediate and final project presentations and reports, and final system demonstration.
Course Learning Outcomes:	<ol style="list-style-type: none">1. Create engineering metrics, performance specifications, technical goals, and verification procedures in the context of a semester-long engineering design project, both individually and as a member of a team.2. Conduct systematic control system design, including conceptualization, performance specification, analytical and empirical modeling, component selection, simulation, controller design, and physical system validation and design iteration.3. Analyze and critically evaluate ideas, including the use of both hand and computer simulations, and experimental data for quantitative support.4. Practice formal oral and written expression and communication (memos, reports, and presentations), both individually and as a member of a team.

5. Develop sensitivity to related professional, societal, and ethical issues.
6. Incorporate, when appropriate, methods and tools from non-Electrical Engineering disciplines.

How Course Outcomes are Assessed:

- Conceptual design memo (team) (5%)
- Project proposal and review (team) (15%)
- Progress report and review (team) (10%)
- Final project report (team) (30%)
- Presentations (proposal review, progress review, final presentation) (individual) (3%+5%+7%=15%)
- Lab notebook (individual) (10%)
- Teamwork (individual, based on team member statement, participation in shop hours, and instructor and TA evaluation) (10%)

Relation to EE/CSE/EPE Outcomes:

N = none
M = moderate
H = high

Outcome	Level	Demonstrate Proficiency
	N, M, H	e.g. Exams, projects, HW
Mathematics, science and engineering	H	Design Project
Basic disciplines in Electrical Engineering	N	
Depth in Electrical Engineering	M	Design Project
Basic disciplines in Computer & Sys. Eng.	N	
Depth in Computer and Systems Eng.	M	Design Project
Electromagnetics, electromechanics, power semiconductors	N	
Power system behavior	M	Design Project
Electrical energy conversion	N	
Conduct experiments and interpret data	H	Design Project
Identify, formulate and solve problems	N	
Design a system, component or process	H	Design Project
Communicate in written and oral form	H	Design Project, Team Meetings, Conceptual Design Memo, Project Proposal & Presentation, Progress Report & Presentation, Final Report & Presentation
Function as part of a multi-disciplinary team	M	Design Project, Team Meetings, Conceptual Design Memo, Project Proposal & Presentation, Progress Report & Presentation, Final Report & Presentation
Preparation for life-long learning	M	Design Project
Ethical issues; safety, health, public welfare	M	Design Project, Team Meetings, Conceptual Design Memo, Project Proposal & Presentation, Progress Report & Presentation, Final Report & Presentation
Humanities and social sciences	N	
Laboratory equipment and software tools	H	Design Project
Variety of instruction formats	H	Mini-Lectures, Team Meetings, Open Shop (consultation with Instructor and TA)

- Topics Covered:** The control system design principles covered include conceptual system design, components selection, modeling and simulation using computer-aided control design tools, real-time programming, engineering design issues, and physical system validation
- Computer Usage:** The design projects make extensive use of MATLAB version 7.1 (with control systems toolbox) and Simulink for design analysis and simulation. For real-time programming, the course uses LabView by National Instruments. Students also may use CAD tools such as SolidWork for component analysis and design.
- Laboratory Experiences:** The course centers around a semester-long team-based control design project. Each team is given a set of components are required to propose, present, design, evaluate, test, and demonstrate a working control system.
- Design Experiences:**
1. Participation in a semester-long design project, with emphasis on relevant control systems modeling, simulation, and design methodology and tools, engineering criteria, performance metrics, design and verification of a working physical system.
 2. Execution of engineering analysis and design in terms of analytical modeling, model identification, uncertainty characterization, control system design, simulation, and experimental validation.
 3. Participation and contribution within, student teams (usually of size 3–5), with complementary individual intra- and inter-disciplinary design skills (mechatronics system modeling, CAD and mechanical design, machining, circuit design, vision and image processing, sensors and signal processing).
 4. Development of awareness and sensitivity to the importance of multi-disciplinary design, and consideration of engineering professional and ethical issues.
 5. Proficiency in the use of control system analysis, design, and programming tools, including MATLAB, Simulink, and LabView.
 6. Maintenance of an individual laboratory notebook.
 7. Contribution and participation in written Reports: Conceptual design memo, proposal, progress report, and final report.
 8. Contribution and participation in oral presentations: proposal, progress, and final presentations. The final presentation requires a short video segment (2-3min) demonstrating the experimental system.
- Independent Learning Experiences:** The design project requires a significant amount of individual work including preliminary research, analysis, design, verification, report writing, presentation preparation, and lab notebook.
- Class/Lab Schedule:** Group Meeting Tu 8:30-9:50, Individual Team Meeting, W 6:00pm–8:30pm. Shop is always accessible through a key lockbox.
- Contribution to the Professional Component:**
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| (a) College-level mathematics and basic sciences: | 0 credit hours |
| (b) Engineering Topics (Science and/or Design): | 3 credit hours |
| (c) General Education: | 0 credit hours |

Prepared by:	John T. Wen
Date:	April 8, 2006