THE UNIVERSITY OF TEXAS AT AUSTIN

ASE370L Flight Control Systems
Spring 2008

SYLLABUS

UNIQUE NUMBER: 13105

INSTRUCTOR: Dr. Robert H. Bishop
Office: WRW215, **Phone**: 471-4596, **email**: rhbishop@mail.utexas.edu

TIME & PLACE: T-Th 11:00pm – 12:30pm in WRW102

TEACHING ASST.: Divya Thakur, WRW408A, divya_th@gmail.com
Office hours: M-W 12-1pm

WEB PAGE: Blackboard

OBJECTIVES:
The main objective is to introduce the student to the fundamentals of systems theory with emphasis on control system design and analysis. Classical control theory in the frequency domain and modern control theory in the state-space are effectively mixed to provide the student with a modern view of systems theory. The primary role of control systems in high-performance aerospace applications is emphasized.

KNOWLEDGE, SKILLS, AND ABILITIES STUDENTS SHOULD HAVE BEFORE ENTERING THIS COURSE:
Students should have a working knowledge of ordinary differential equations and solution methods, and should have significant experience developing mathematical models of simple electro-mechanical systems (such as mass-spring-damper systems) starting from basic principles (Newton's laws, conservation of momentum, etc.). Students should have been introduced to frequency response methods (including an understanding of Bode plots) and should understand the basic properties of linear systems, including convolution and the application of Laplace transforms.

KNOWLEDGE, SKILLS, AND ABILITIES STUDENTS GAIN FROM THIS COURSE:
Students will understand the fundamentals of system theory, including a working knowledge of classical and modern control system design and analysis for single-input, single-output systems. Students will be able to design and analyze control systems using root locus methods, frequency response methods (including Bode and Nyquist methods), and full-state feedback pole placement methods in the state-space. Students will develop a basic understanding of the notion of system stability and relative stability using Routh-Hurwitz methods, gain and phase margin notions from Bode and Nyquist, the Nyquist stability criterion, and by associating the location of system poles (eigenvalues for state-space models) on the s-plane with system response. System performance for standard test signals will be introduced, including both transient and steady-state response.

IMPACT ON SUBSEQUENT COURSES IN CURRICULUM:
The material in this course is essential in the design courses that follow that require the application of feedback control systems. Since the performance of most modern aerospace vehicles depends on the performance of their control systems, most ASE student design teams will consider design issues that rely on knowledge gained in ASE370L Flight Control Systems.

ABET CRITERIA 2000 OUTCOMES ACHIEVED:
This course contributes to the following EC2000 Criterion 3 outcomes and those specific to the EAC accredited program.

Outcome	√	**Outcome**	√
a. An ability to apply knowledge of mathematics, science, and engineering	√	g. An ability to communicate effectively	
b. An ability to design and conduct experiments, as well as to analyze and interpret data		h. The broad education necessary to understand the impact of engineering solutions in a global/societal context	
c. An ability to design a system, component, or process to meet desired needs	√	i. A recognition of the need for and an ability to engage in life-long learning	
d. An ability to function on multi-disciplinary teams		j. A knowledge of contemporary issues	
e. An ability to identify, formulate, and solve engineering problems	√	k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	√
f. An understanding of professional and ethical responsibility		l. Begin list of any other outcomes unique to the program.	

ABET PROGRAM CRITERIA OUTCOMES ACHIEVED:

Criterion	√	**Criterion**	√	**Criterion**	√
A. Aerodynamics		G. Orbital Mechanics		M. Preliminary/Conceptual Design	√
B. Aerospace Materials		H. Space Environment		N. Other Design Content	
C. Structures		I Attitude Determination and Control		O. Professionalism	
D. Propulsion		J. Telecommunications		P. Computer Usage	√
E. Flight Mechanics		K. Space Structures			
F. Stability and Control	√	L. Rocket Propulsion			

PROFESSIONALISM TOPICS:
Lectures are interwoven with discussion of ethics and teamwork based on instructor's personal experience in industry. Current events that involve aspects of control systems are discussed at the beginning of each lecture with special attention to the impact of design success and failures on society.

TOPICS:
Introduction to open- and closed-loop control systems and examples (a, c, e, i),(F, M)
Differential equation models of physical systems and solution methods (a, c, e)
Linear approximation of systems (a, e)
Laplace transforms, transfer functions, and block diagrams (a, e)
Input-output system models (a, e)
State-variable system models and relationships to input-output system models (a, e)
Feedback system characteristics-steady-state and transient response, disturbance rejection,
Sensitivity, second-order systems and development of design formulas (a, e), (F)
Stability-Routh-Hurwitz criterion, relative stability, gain and phase margins, Nyquist stability

Criterion (e), (F, P)
Root locus design methods (c, e, g, k), (F, I, M, P)
System bandwidth (a, e)
Frequency response design methods-Bode design and Nyquist analysis (c, e, g, k), (F, I, M, P)
Controller design: PID, lead, lag, full-state feedback, and other controllers (c, e, k), (F, I, M, P)
Design of feedback systems in the frequency- and time-domains (c, e, g, k), (F, I, M, P)
Observability and controllability (a, e)
Computer-based design methods (i), (M, P)

DESIGN ASSIGNMENTS
Two take-home examinations are design projects.

LABORATORY ASSIGNMENTS:
No laboratory assignments.

COMPUTER:
Students are strongly encouraged to use computers whenever possible. Resources are available in the Learning Resource Center WRW 205. Control system design and analysis will be accomplished with the aid of Matlab and/or LabVIEW.

TEXT:
Modern Control Systems, 11th Ed. by R. C. Dorf & R. H. Bishop

CLASS FORMAT:
Lecture format.

CLASS SCHEDULE (APPROXIMATE):

Week 1 Chapter 1: Introduction to Control Theory and Flight Controls
Homework #1
Week 2-3 Chapter 2: Mathematical Models of Systems and Chapter 3: State Variable Models
Homework #2 and #3
Week 4-5 Chapter 4: Feedback Control System Characteristics and Chapter 5: The Performance of Feedback Control Systems
Homework #4 and #5
Week 6 Chapter 6 The Stability of Linear Feedback Systems
Homework #6
Week 7 Review and In-Class test #1
Week 8-9 Chapter 7: Root-Locus Design
Homework #7 and 8
Take-home test #2
Week 10-11 Chapter 8: Frequency-Response Design
Homework #9
Take-home test #3

Week 12 Chapter 9: Stability in the Frequency Domain
Homework #10
Week 13-14 Chapter 11: Design of State Variable Feedback Systems
Homework #11
May 10 Final Examination

GRADING:
3 exams (1 in-class and 2 take-home) (60%)
Homework (20%)
Final Examination (20%)

HOMEWORK POLICY:
There will be roughly one homework assignment per week, except for weeks with examinations. Each assignment is due one week after assignment or as otherwise noted. Late homework does not exist.

EXAMINATIONS:
There will be three examinations. The first examination is in-class, while the second and third examinations are take-home examinations with a design emphasis. Two take-home examination will require the design of a control system for aerospace vehicles. All examinations are individual work. The Final Examination will be held at the UT scheduled examination day and time (May 10, 2-5pm).

ATTENDANCE: Regular attendance is expected.

BISHOP'S OFFICE HOURS:
T-Th 10:00 - 11:00 am, by appointment, or send e-mail anytime.

IMPORTANT DATES:
(a) Jan. 30 - Last day to drop a course for a possible refund
(b) Feb. 11 - Last day to drop a course without possible academic penalty
(c) Mar. 24- Last day to drop a course (with dean's approval)

SPECIAL NOTES:
The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.

EVALUATION:
Measurement and Evaluation Center forms for the College of Engineering will be used during the last week of class to evaluate the course and the instructor.