INC (EN-3603/4223)- Instrumentation & Control

Control - SPRING 2016

Course Abstract: Control is a relatively complex subject affecting almost every aspect of our lives. This course will provide a foundation for understanding the dynamic (changing over time) behavior of all *systems*: mechanical, electrical, fluid, nuclear, biological and even economic. These systems are modeled and analyzed using a variety of methods, and the dynamic behavior is simulated in software. A *controller* is typically designed by adding closed-loop feedback and controller dynamics to improve the quality of the system response to a variety of inputs. This course will prepare you for graduate classes in modern control, for work in automatic control system design and advanced controller applications. The class will also prepare you for the "Modeling of Engineering Systems" and the "Analysis of Engineering (Dynamic) Systems" sections of the Engineer in Training Examination (Professional Engineering).

TEXT: **Modeling and Analysis of Dynamic Systems**
Close, C.M., and Frederick, D.K.
3rd Edition (copyright 2002), John Wiley & Sons

INSTRUCTOR:

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Room: HA-222 (Harrington 2nd Deck)

CLASS: Monday, Wednesday, and Friday
Section EN-4223-x11-from 08:00 to 08:50 Hours (1st Period)
Room: BR-222 (Bresnahan Electronics & Controls Laboratory)

NLAB: Instrumentation & Controls Laboratory
Tuesday x25@NOON and x27@1400 in BR-222 (EIC Lab)
NLab is only required for ESE-ABET Students

STCW: Both Class and Lab are required to satisfy USCG-STCW.
The STCW Knowledge elements are listed on the next page.

This course is an acceptable substitute for **EN-3216 Operational Controls**, The STCW requirements of EN-3216 will be met with a "C-" or better.

ATTENDANCE:

Attendance is tracked to satisfy USCG-STCW requirements.
Lack of regular attendance will impact your Final Grade.

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GRADING:

Grades are based on homework (PSets and iLabs), quizzes, and exams.
iLabs are electronic assignments using Matlab/Simulink, and are designed to demonstrate competency in each part of the Instrumentation & Control class:
1) Modeling, 2) Analysis, and 3) Controller Design.

INC Assignments are made via email.
Late work will NOT be accepted.

INC COURSE GRADE METRIC:

Each Exam will build-on and APPLY the Knowledge from previous Exams.

Exam1 (Modeling)	20%
Exam2 (Analysis)	20%
Exam3 (Control - Final)	20%
Quizzes (anytime baby!)	20%
Homework (PSets & iLabs)	20%
Total Grade	100%

INC USCG-STCW Elements:

Covers instrumentation and control fundamentals and applications to facility systems including documentation. Both analog and digital control systems are covered. It is also an introduction to programmable logic controllers. This course addresses the following STCW Knowledge elements:

OICEW-A4.1 Basic construction and operation principles of automatic control systems
OICEW-A5.1 Operational characteristics of control systems
OICEW-B1.1 Basic configuration and operation principles of sequential control circuits
OICEW-B1.2 Flowchart for automatic and control systems
OICEW-B1.2 Functions, characteristics and features of control systems for machinery
OICEW-B1.3 Various automatic control methodologies and characteristics
OICEW-B1.3 Proportional–Integral–Derivative (PID) control characteristics
OICEW-B1.3 Associated system devices for process control
OICEW-B1.3 Configuration and operation principles of control systems
OICEW-B2.5 Function and performance tests of electronic monitoring systems
OICEW-B2.5 Function and performance tests of electronic automatic control devices
OICEW-B2.5 Function and performance tests of electronic protective devices

INC-Syllabus with Outcomes by Chapter & Activity

INC- Instrumentation and Control, gives students the engineering tools needed to study a wide variety of dynamic systems and controllers, regardless of their physical origin (i.e., Mechanical, Electrical, Thermal, Economic, Social; the changes in any dynamic system). The textbook (Modeling and Analysis of Dynamic Systems) includes detailed modeling of mechanical, electrical, electro-mechanical, thermal, and fluid systems. In this class, dynamic models are developed in the form of state-variable equations, input-output differential equations, transfer functions, and block diagrams. The Laplace transform is used for analytical solutions (calculation-based), and additional computer solutions are based on Matlab/ Simulink software. Application case studies look at marine and power systems, and related components. The final third of the class examines the design tools for closed-loop feedback control systems using Matlab & Simulink.

Part I: Dynamic System Modeling

Chap 1. Introduction: Develop an understanding of PID Controls & System I/O
Chap 2. Translational Mechanical Systems: Develop LODE Models for MBK Translation
Chap 3. Standard Forms for System Models: Develop A,B,C,D Modern Control Formats

Part II: Control System Analysis

Chap 4. Block Diagrams and Computer Simulation: Apply Simulink to Part I LODEs
Chap 7. Transform Solutions of Linear Models: Derive Laplace Transforms for LODEs
Chap 8. Transfer Function Analysis: Develop 1°, 2°, & Nth° System Transform solutions

Part III: PID Controller Design

Chap 13. Block Diagrams for Dynamic Systems: Develop Closed Loop Control Systems
Chap 14. Modeling, Analysis, and Design Tools: Develop PID Design Solutions
Chap 15. Feedback Design with MATLAB: Examine practical PID Matlab Designs

iLabs: Develop a simple, physical Coke Can Parametric LODE Model

DC Servo-Motor Case Study: Develop a practical PID Control Example

Examine a Combined Electro-Mechanical System
Examine Closed-Loop Speed Controller Design
Examine Closed-Loop Position Controller Design

Matlab/Simulink Software: Learn & Apply to Design & Implement.

Use Matlab Controls Tutorials & Application Case Studies
Apply Classical Laplace Transforms to Modeling & Simulation
Use Simulink Tool Library Graphical Modeling & Simulation
Apply Modern State-Space Matrix Modeling & Simulation

and will briefly discuss (time permitting): Chap 5. Rotational Systems, Chap 6. Electrical Systems, and Chap 10. Electro-Mechanical Systems (with models used as examples).