ME 57500 THEORY AND DESIGN OF CONTROL SYSTEMS

Course Outcomes

- 1. Discuss *feedback control* system characteristics (stability & performance).
- 2. Provide tools to analyze *robustness* to plant uncertainty.
- 3. Describe methods for *frequency-domain loop shaping*.
- 4. Introduce *state-space representation*.
- 5. Cover state feedback regulator design.
- 6. Cover state observer design.
- 7. Develop *optimal control design methodology*.

Closed-Loop System Attributes (2 wks)

- 1. Feedback
- 2. Sensitivity and complementary sens.
- 3. Closed loop stability
- Steady state performance
- 5. Norms
- 6. Robustness to plant uncertainty

Frequency Domain Loop Shaping (3 wks)

- 1. Constraints on achievable performance
- 2. Frequency domain controller design
- 3. Design examples
- 4. Nonminimum phase systems & time delay

State-Space Representation (2 wks)

- 1. Controllable and observable canonical forms
- 2. Eigenvalues and eigenvectors
- 3. Jordan canonical form
- 4. State transition matrix

State Feedback and Output Feedback (5 wks)

- 1. Controllability
- 2. State feedback regulator design
- 3. Observability
- 4. Observer design
- 5. Reduced observer design
- 6. Tracking control

Optimal Control (3 wks)

- 1. Calculus of variations
- 2. Pontryagin's principle
- 3. Linear quadratic regulator design
- Optimal observer design

1. COURSE NUMBER AND NAME: ME 57500 Theory and Design of Control Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

P.H. Meckl

4. TEXTBOOK:

Goodwin, Graebe, Salgado, *Control System Design*, Prentice Hall, 2001.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Course covers the analysis and design of control systems from both a classical and modern viewpoint, with emphasis on design of controllers. Classical control design is reviewed, including both root locus and Bode domain design methodologies. The state space representation is introduced, along with notions of stability, controllability and observability. State feedback controllers for pole placement and state observers are discussed with emphasis on their frequency domain implications. Typically offered in the fall.

b. Prerequisites:

ME 47500 – Automatic Control Systems

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

- 1. Discuss *feedback control* system characteristics (stability and performance).
- 2. Provide tools to analyze *robustness* to plant uncertainty.
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- 7. Develop optimal control design methodology.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals; B3. Prof/Ethical Responsibility;

A2. Analytical Skills; B4. Contemporary Issues;

A3. Experimental Skills; B5. Life-Long Learning;

A4. Modern Engr Tools; C1. Leadership,

A5. Design Skills; C2. Global Engineering Skills;

A6. Impact of Engr Solns; C3. Innovation;

B1. Communication Skills; C4. Entrepreneurship

B2. Teamwork Skills

7. LIST OF TOPICS: See following page.

PREPARED BY: P.H. Meckl **REVISION DATE:** June 26, 2012