MECHANICAL ENGINEERING PROGRAM

ABET COURSE SYLLABUS

ME 422 Mechanical Control Systems (4 Units) Elective

Course Description: (2019-20 Catalog) Modeling and control of physical systems. Design of mechanical, hydraulic, and electrical systems using time response, frequency response, state space, and computer simulation. 3 lectures, 1 laboratory.

Prerequisite Courses: ME 318

Prerequisites by Topic:
Differential Equations and LaPlace transforms
Mechanical Vibrations
Basic computer programming and use

Textbook: (and/or other required material) Control Systems Engineering, 7th Edition, by Norman S. Nise, John Wiley & Sons, 2015.

References: Course website, MATLAB/Simulink on-line help

Course Coordinator/Instructor: Charles Birdsong, Professor of ME

Course Learning Outcomes:

1. Students can formulate physical system models with linear differential equations and transfer functions.
2. Students can demonstrate the process and assess the assumptions and errors involved in linearizing system models.
3. Students can evaluate system error, response time and stability.
4. Students recognize the benefits derived by the addition of feedback, together with its disadvantages, such as instability.
5. Students can categorize systems according to order and type in order to estimate the probable response to transient and sinusoidal inputs and disturbances.
6. Students can predict the effects of proportional, integral and derivative control actions, together with their combinations on system response.
7. Students can apply methods such as Bode plots and root locus for designing control systems.
8. Students can apply system compensation and compensation elements in design.
9. Students can employ digital computers in the assessment of system response and in parameter selection in design.

Relationship of Course to Mechanical Engineering Student Outcomes:	SO 1: Mastered (M) SO 2: SO 3: SO 4:	SO 5: Mastered (M) SO 6: Mastered (M) SO 7:

Topics Covered:

1. Modeling (with differential equations) of basic electrical, mechanical, fluid and thermal systems. Development of analogies between them.
2. Response, using differential equations, of first, second and higher order systems to various inputs.
3. Use of LaPlace Transform techniques in solving the system equations.
4. Transfer function models of physical devices and feedback components.
5. Development of block diagrams or signal flow graphs using functions.
6. Analysis of proportional, integral and derivative control actions.
7. Use of root locus method.
8. Frequency response analysis of feedback systems.
9. Use of Bode diagrams in assessing system response and stability.
10. System compensation analysis, devices and design.

Laboratory Projects:

1. Modeling of physical systems using digital computer simulation.
2. Experimental determination of dynamic properties and closed-loop response of an electromechanical DC servo control system.
3. Experimental determination of dynamic properties and closed-loop response of a two-tank fluid level control system using valve control.
4. Experimental determination of dynamic properties and closed-loop response of an electro-hydraulic or pneumatic positioner system.
5. Design of PID controller for hydraulic positioner system based on experimental frequency response data.

Class/Lab Schedule: Three 50-minute lectures per week, one 170-minute lab per week

Contribution of Course to Meeting the Professional Component:

(a) College-level mathematics and basic sciences:	0 credits
(b) Engineering Topics:	3 credits
Design	1 credit
(c) General Education:	0 credits
(d) Other:	0 credits

Prepared by: Charles Birdsong

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