ME 4452 Control of Dynamic Systems (Elective)

Catalog Description: ME 4452 Control of Dynamic Systems (3-0-3)
Prerequisites: ME 3017 System Dynamics
Modeling and simulation of dynamic systems in frequency and time domains. Feedback control analysis and design methods including root-locus, frequency response, and pole-placement. Introduction to digital control systems.

Textbook: Norman S. Nise, *Control Systems Engineering*, 6th Edition, Wiley, 2010.

References: Katsuhiko Ogata, *Modern Control Engineering*, 5th Edition, Prentice Hall, 2009.

Topics Covered:

1. Modeling in the Laplace domain
2. Modeling in the time domain
3. Time response analysis and specifications
4. Stability analysis
5. Steady-state errors
6. Root-locus control design
7. Frequency response control design
8. State-space control design
9. Introduction to digital control systems
10. Control system applications and case studies

Course Outcomes:

Outcome 1: To teach students to perform a mathematical analysis of engineering dynamic systems in the time and frequency domains.

1.1 Students will demonstrate an understanding of various mathematical models, such as differential equation and transfer function models.

1.2 Students will demonstrate the ability to formulate state-space models of dynamic systems.

1.3 Students will demonstrate the ability to linearize the dynamic model of nonlinear systems.

Outcome 2: To develop students' understanding of stability, transient, and steady-state behavior of linear dynamic systems.

2.1 Students will demonstrate the ability to formulate the time response of a linear system based on its transfer function or state-space model.

2.2 Students will demonstrate the ability to derive the frequency response of a linear system and to construct its Bode diagrams.

2.3 Students will demonstrate the ability to identify a dynamic system from its time or frequency response.

2.4 Students will demonstrate how to evaluate the stability of dynamic systems both in the time and frequency domains.

2.5 Students will demonstrate an understanding of the transient and steady-state response specifications for dynamic systems.

Outcome 3: To develop students' skills in analyzing and designing feedback controllers in the time and frequency domains.

3.1 Students will demonstrate the ability to reduce block diagrams of multiple subsystems.

3.2 Students will demonstrate that they can analyze and design controllers using the root-locus technique.

3.3 Students will demonstrate the ability to design control compensation using frequency domain techniques.

3.4 Students will demonstrate an ability to design controllers in the time-domain using state-space methods.

3.5 Students will demonstrate when and how to apply various control design techniques to real-world engineering systems.

3.6 Students will demonstrate the ability to evaluate the performance of control systems by simulation.

Correlation between Course Outcomes and Student Outcomes:

ME 4452											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	X										
Course Outcome 1.2	X										
Course Outcome 1.3	X										
Course Outcome 2.1	X				X						
Course Outcome 2.2	X				X						
Course Outcome 2.3	X				X						
Course Outcome 2.4	X				X						
Course Outcome 2.5	X				X						
Course Outcome 3.1					X						
Course Outcome 3.2					X						
Course Outcome 3.3					X						
Course Outcome 3.4					X						
Course Outcome 3.5										X	X
Course Outcome 3.6										X	X

GWW School of Mechanical Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

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