ME 4012 Modeling and Control of Motion Systems (Elective)

Catalog Description: ME 4012 Modeling and Control of Motion Systems (2-3-3)

Prerequisites: ME 3017 System Dynamics

Motion systems consisting of mechanical, fluid, and electrical components are analyzed, modeled, and controlled. Alternatives are considered for system optimization.

Textbook: Katsuhiko Ogata, *System Dynamics*, 4th Edition, Prentice Hall, 2004.

Topics Covered:

Lecture

1. System dynamics and control; continuous-time control systems.
2. Computer-controlled systems; discrete-time control systems; the Z transform.
3. Feedback control systems; linearity and nonlinearity; actuators; sensors; modeling; PID tuning.
4. Microfluidic control systems; biomimetic microsystems; nanomedicine; cell diagnostics.
5. Human interfaces; robots; medical devices; mobile equipment; transportation; manufacturing.

Laboratory

1. LabVIEW and MATLAB SIMULINK.
2. Industrial motion control components – Rockwell demo stations.
3. Precision control systems – closed-loop control of microfluidic pressure.
4. Robotic arm/manipulator control/tuning.
5. Control system design project.

Course Outcomes:

Outcome 1: Students will model the components of motion systems.

- 1.1 Students will be able to derive dynamic models of actuators in a motion system.
- 1.2 Students will be able to obtain parameters for the actuators from experiments.
- 1.3 Students will be able to obtain the models from system identification techniques.
- 1.4 Students will be able to express these models in transfer function and state space form.
- 1.5 Students will be able to use these models for control system design.

Outcome 2: Students will design and implement control algorithms for motion systems.

- 2.1 Students will be able to incorporate specifics and limitations imposed by kinematics, energetics, material properties and structural design into a conceptual design of a motion system.
- 2.2 Students will be able to design feedback control algorithms.
- 2.3 Students will be able to structure motion profiles to achieve specifications of the design.
- 2.4 Students will be able to implement the profiles in real-time digital control prototyping software (e.g. SIMULINK, LabVIEW).
- 2.5 Students will be able to conceptualize and implement simple supervisory algorithms in industrial hardware (e.g. Programmable Logic Controllers).

Outcome 3: Students will be able to formulate solutions to systems requiring controlled motion.

- 3.1 Students will understand the rationale for approaches taken in some example applications.
- 3.2 Students will be able to apply engineering principles to realistic problems proposed.

3.3 Students will be able to evaluate and explain the strengths and weaknesses of motion systems.

Correlation between Course Outcomes and Student Outcomes:

ME 4012											
	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	X									X
Course Outcome 1.3	X		X		X						X
Course Outcome 1.4	X		X		X						X
Course Outcome 1.5			X		X						X
Course Outcome 2.1	X		X		X						
Course Outcome 2.2	X	X	X		X						X
Course Outcome 2.3	X	X			X						X
Course Outcome 2.4	X		X	X	X						X
Course Outcome 2.5	X		X	X	X						X
Course Outcome 3.1			X		X						
Course Outcome 3.2	X		X		X						
Course Outcome 3.3	X	X	X		X		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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