

## 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 including mechanical, fluid, and electrical components are analyzed, modeled, and controlled. Students will implement controllers for dynamic and robotic systems in the laboratory.

**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. Human interfaces; robots; medical devices; mobile equipment; transportation; manufacturing.

#### Laboratory

1. LabVIEW, MATLAB SIMULINK, and Microcontrollers.
2. Precision control systems.
3. Control/tuning of robotic systems.
4. 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