ME 4451 Robotics (Elective)

Catalog Description: ME 4451 Robotics (2-2-3)
Prerequisites: ME 3017 System Dynamics
Mathematical modeling, simulation, and control of robotic systems with mechanical and sensory elements.

Textbook: No textbook.

References: John J. Craig, *Introduction to Robotics: Mechanics and Control*, 3rd Edition, Addison-Wesley, 2004.

Topics Covered:

1. Robot applications: industrial manipulators, robotic hands, wheeled vehicles, locomotion.
2. Freedom and constraint: object degrees-of-freedom, joints, kinematic mobility, bilateral and unilateral constraints.
3. Displacement kinematics: forward and reverse displacement for serial and parallel robots, displacement singularities.
4. Static analysis: end-effector and joint loading for serial and parallel robots, general singularities.
5. Velocity kinematics; forward and reverse displacement for serial robots, parallel robots, and mobile vehicles, Jacobians, general singularities.
6. Task planning: trajectory planning for holonomic robots and AI-based path planning for nonholonomic robots.
7. Vision: image processing and feature extraction.
8. Laboratory: control of serial manipulators, parallel manipulators and mobile vehicles; image acquisition and processing; simulation with software.

Course Outcomes:

Outcome 1: To teach students basic mathematical and computational tools for modeling and analysis of robotic systems.

1.1 Students will demonstrate an understanding of various mathematical models, such as joint and link models for serial and parallel manipulators, transformations between joint space and end-effector space, and Jacobians for velocity and static analysis.

1.2 Students will demonstrate the ability to perform path planning using algebraic techniques for holonomic robots and artificial intelligence techniques for nonholonomic robots.

Outcome 2: To train students to identify, model, analyze, design, simulate, and implement robotic systems.

2.1 Students will demonstrate the ability to simulate the kinematics and control of robotic systems.

2.2 Students will demonstrate the ability to integrate sensory and mechanical components within a robotic system.

Correlation between Course Outcomes and Student Outcomes:

ME 4451											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	X				X						X
Course Outcome 1.2	X				X						X
Course Outcome 2.1	X				X						X
Course Outcome 2.2	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

Prepared by: Harvey Lipkin and Nader Sadegh