Subject:	ROBO
Course Number:	190
Descriptive Title:	Advanced Robotics II
Division:	Industry and Technology
Department:	Robotics
Course Disciplines:	Electronics and Computer Hardware Technology, Manufacturing Technology
Catalog Description:	This advanced course explores bipedal humanoid robotic applications, with an emphasis on humanoid robot kinematics, Zero Moment Point (ZMP) and dynamics, biped walking, generation of whole-body motion patterns, and dynamic simulation. This course will serve as the final installment of the robotics pathway.
Prerequisite:	Robotics 170 with a minimum grade of C
Co-requisite:	
Recommended Preparation:	
Enrollment Limitation:	
Hours Lecture (per week):	2
Hours Laboratory (per week):	3
Outside Study Hours:	4
Total Course Hours:	90
Course Units:	3
Grading Method:	Letter Grade only
Credit Status:	Credit, degree applicable
Transfer CSU:	Yes
Effective Date:	
Transfer UC:	Yes
Effective Date:	pending
General Education ECC:	
Term:	
Other:	
CSU GE:	
Term:	
Other:	
IGETC:	
Term:	
Other:	
CalGETC:	

Term:	
Other:	
Student Learning Outcomes:	1. SLO #1 – HUMANOID ROBOT ORIENTATION AND OVERVIEW The student will be able to define what a humanoid robot is, identify the applications of humanoid robots and related subsystems of the varying humanoid robot types. 2. SLO #2 – HUMANOID ROBOT FABRICATION The students will be able to perform successful 3D printing of hardware components as part of building a humanoid robot. Materials and hand tools will be provided. 3. SLO #3 – HUMANOID ROBOT OPERATIONAL PERFORMANCE By the end of this course, students will be able to construct, program and test a humanoid robot.
Course Objectives:	1. Define a humanoid robot, identify the purpose/applications of a humanoid robot. 2. Understand and articulate humanoid robot kinematics. 3. Explain the algorithms used in humanoid robot kinematics. 4. Articulate the different types of perception available for humanoid robots, including hardware and software. 5. Understand the issues of humanoid robot localization, including identifying various techniques available to resolve. 6. Differentiate between the various forms of planning and navigation challenges of humanoid robots, including applying various algorithms to help a humanoid robot achieves its goal/objective. 7. Build a humanoid robot with 3D-printed parts, test, operate and debug errors. 8. Demonstrate mastery of the Jacobian matrix. Explain what a Jacobian matrix is, and how it is applied towards a humanoid robot.
Major Topics:	I. HUMANOID ROBOT OVERVIEW (2 hours, Lecture) A. Timeline of humanoid robot development B. Sensors used in humanoid robots II. HUMANOID KINEMATICS (6 hours, Lecture) A. Coordinate transformations B. Rotational motion characteristics C. Velocity D. Data structure and programming E. Forward kinematics F. Inverse kinematics G. Jacobian matrix H. Singularities III. ZMP AND DYNAMICS (6 hours, Lecture) A. ZMP overview B. Ground reaction forces

	C. ZMP measurements D. Humanoid robot dynamics E. Calculation of ZMP IV. BIPED WALKING (8 hours, Lecture) A. 2D walking pattern generation B. 3D walking pattern generation C. ZMP based walking pattern generation D. Stabilizer E. Additional methods for biped control V. GENERATION OF WHOLE-BODY MOTION PATTERNS (8 hours, Lecture) A. How to generate whole-body motion patterns B. Generating rough whole-body motion C. Converting patterns to dynamically stable motion D. Remote operation E. Reducing impact of humanoid robot falling backwards F. Methods to help humanoid robots get up again VI. DYNAMIC SIMULATION (4 hours, Lecture) A. Dynamics of rotating rigid body B. spatial velocity C. Dynamics of rigid body D. Dynamics of link system E. Featherstone's method F. Subroutines VII. HUMANOID ROBOT DESIGN (20 hours, Lab) A. Goals and objective identification B. Drawing or Computer Aided Design (CAD) of humanoid robot design C. Subsystem identification D. Sensor selection E. Perception selection F. Navigation parameters G. Algorithm selection VIII. HUMANOID ROBOT TESTING AND DEBUGGING (24 hours, Lab) A. Testing humanoid robot on level platform B. Debugging hardware, software, sensor errors C. Making adjustments to other subsystems where needed IX. HUMANOID OPERATION (10 hours, Lab) A. Performing a goal on a level platform B. Developing mechanism for helping humanoid robot get off ground
Total Lecture Hours:	36

Total Laboratory Hours:	54
Total Hours:	90
A.1. Primary Methods of Evaluation (Part 1 - CCN courses only):	
Primary Method of Evaluation:	3) Skills demonstration
Typical Assignment Using Primary Method of Evaluation:	In a three- to five-page report, examine components of a bipedal humanoid robot and demonstrate knowledge of subsystems and how they interact with one another. Submit assignment to instructor for evaluation.
Critical Thinking Assignment 1:	Construct on paper or with Computer Aided Design/Drafting (CADD) software a bipedal humanoid robot based on a problem to be solved, justifying type, sensor selections, and subsystems. Submit robot design to the instructor.
Critical Thinking Assignment 2:	Present and operate a humanoid robot with 3D-printed parts. Consult instructor for evaluation.
Other Evaluation Methods:	Class Performance, Completion, Matching Items, Multiple Choice, Presentation, True/False, Written Homework, Journal kept throughout course, Laboratory Reports, Quizzes
If Other:	
Instructional Methods:	Demonstration, Guest Speakers, Lab, Lecture, Multimedia presentations
If other:	
Work Outside of Class:	Course is lab only - minimum required hours satisfied by scheduled lab time, Journal (done on a continuing basis throughout the semester), Required reading, Written work (such as essay/composition/report/analysis/research)
If Other:	
Up-To-Date Representative Texts:	Kajita, S., Hirukawa, H., Harada, K., & Yokoi, K. Introduction to Humanoid Robotics. 2014. *Springer.* First Edition (Discipline Standard)
Alternative Texts:	
Required Supplementary Readings:	
Other Required Materials:	
Requisite	Prerequisite
Category	sequential
Requisite course:	Robotics 170
Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s).	**Design appropriate gear and drive trains for robotic systems.** ROBO 170 - Differentiate between the various forms of planning and navigation challenges of a mobile robot in a variety of environments, including applying various algorithms to help a mobile robot navigate and achieve its goal/objective. **Build robotic systems in accordance with industry standard schematics and diagrams.**

	ROBO 170 - Demonstrate a basic understanding of the various subsystems involved in building and deploying a mobile robot. ROBO 170 - Build a mobile robot with provided materials or 3D-printed parts, test, operate and debug errors.
Requisite Skill:	
Requisite Skill and Matching skill(s): Bold the requisite skill(s). if applicable	
Requisite course:	
Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s).	
Requisite Skill:	
Requisite Skill and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s). if applicable	
Enrollment Limitations and Category:	
Enrollment Limitations Impact:	
Course Created by:	Joseph Weichman
Date:	10/06/2024
Original Board Approval Date:	03/24/2025
Effective Term:	Fall 2025