

ME 425/625: Intro to Robotics

CREDIT HOURS	3 Credit Hours		
PREREQUISITES	ME 242, MATH 431		
COURSE DAY/TIME/LOCATION	Day(s): Mondays	Time: 18:00-20:30	Location: FAB
INSTRUCTOR	Paul Oh		
E-MAIL	paul.oh@unlv.edu		
OFFICE LOCATION	FAB (Flamingo Auxiliary Building)		
OFFICE HOURS	Mondays 17:00-18:00 and by appointment		

REQUIRED TEXT: None

COURSE DESCRIPTION

Course Catalog Description: “Instruction to basic concept and theory behind motions generated by robot manipulators; kinematics, dynamics, and trajectory generation. Design of basic feedback position controllers and computer simulation techniques of robot dynamics and control system.”

Additional (on course syllabus and website): “This course serves Masters-level and/or senior undergraduate students. Mechanisms and electronics are the 2 essential elements of every robotics system. This course (Robotics 1) has the objective of equipping students with a library of the most common mechanisms and algorithms needed to construct working robotic systems. Class time labs are used to reinforce lectures. The theory and construction of levers, shafts, cranks, cams, springs, linkages, ratchets, drives and gears will be studied and built. Algorithms for several control theories will be studied and programmed.

STUDENT LEARNING OUTCOMES

Upon completion of this course, students will be able to:

Provide a “hands-on” experience with robotic sensors, actuators, communications, control, computer vision, and trajectory generation	An understanding the 6 fundamental components of robotics
Relate mechanical, electrical and computer engineering concepts to design, control, and interface robots	An understanding of and application of hardware and software concepts to realize robots
Develop the ability to work together in groups and the organizational and leadership skills required to perform a technical analysis and engineering evaluation	An increased skill level in general experimental methods, systems integration, and effective report writing

ABET OUTCOMES

(0 = No content; 1 = some content; 2 = significant content)

Objective	Content	Explanation	Evidence*
1. To deliver a comprehensive mechanical engineering curriculum which emphasizes both the foundations and breadth of the mechanical engineering profession	2	Advanced laboratory experience in robotics	Project reports and lab exercises
2. To provide an education that equips students with the tools necessary to become successful mechanical engineers based on their experience, strong communication skills and awareness for the need of continuous professional development.	2	Students are exposed to hardware and software tools, simulation and report writing.	Class discussions, project reports, class handouts.
3. To provide an education that will allow mechanical engineering students to understand the social, economic, environmental, political and ethical importance of their future profession.	1	Digital concepts through hardware and software are essential in the design of robotic systems in automobiles, power plants and other vital areas of the economy.	Brief videos of robots and robot-based platforms for society e.g. driverless cars are introduced and discussed.
4. To provide mechanical engineering students with a thorough understanding of impact of mechanical engineers and the mechanical engineering profession in the development, implementation and creation of future technology	2	Development and innovation of robotics will be part of the future technology	Brief videos of robots and robot-based platforms for society e.g. driverless cars are introduced and discussed.

Relation to ABET Criteria 3 Learning Outcomes

(0 = No content; 1 = some content; 2 = significant content)

Criteria a - k	Content	Explanation	Evidence
a. <i>An ability to apply knowledge of mathematics, science and engineering</i>	2	Relevant physics, equations of motion, state space realizations and control techniques are derived	In-class lectures, lab exercises and homework
b. <i>An ability to design and conduct experiments as well as to analyzed and interpret data</i>	2	Students write software and interface mechanical and electrical hardware. They are also required to analyze and interpret the experimental data in the report.	Lab exercises and projects
c. <i>An ability to design a system, component or process to meet desired needs</i>	2	Controllers are both simulated and implemented experimentally.	Lab Exercises and projects
d. <i>An ability to function on multidisciplinary teams</i>	2	Students work as a team to use their knowledge in electronics, and computers to achieve the objective of each experiment in this course.	Lab Exercises and projects

e. An ability to identify, formulate and solve engineering problems	2	The students are required to formulate and solve the control problem based on theory and to verify their experimental results with expected theoretical results.	Lab exercises and homework
f. An understanding of professional and ethical responsibility	1	This is emphasized as part of the design engineer's overall responsibility.	Guest Lecturers
g. An ability to communicate effectively	2	Oral and written presentations of the experimental procedure and results are required.	Project reports
h. The broad education necessary to understand the impact of engineering solutions in a global or societal context	1	The impact of engineering design on the environment (pollution, greenhouse effect, etc.) and society are covered.	Videos and discussion
i. A recognition of the need for and an ability to engage in lifelong learning	1	Improvements in control come from innovations and advanced technology. Need for lifelong learning is recognized.	Videos and discussion
j. A knowledge of contemporary issues	1	Design of control systems is related to contemporary issues	Videos and discussion
k. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice	2	Students use modern engineering instrumentation and software	Lab exercises and project reports

GRADING

Grades are based upon student performance on assignments.

Each assessment tool is weighed as follows:

Item	Scheme
Attendance (Lectures and Labs)	5%
Projects (2 projects at 10% each)	20%
Homework:	25%
Mid-term	25%
Final	25%

GRADING SCALE

Letter grades are assigned according to the following scale:

AO	85-100		C+	60-64
A-	80-84		CO	55-59
B+	75-79		C-	50-54
BO	70-74		D	45-49
B-	65-69		F	0-44

UNIVERSITY POLICIES (UPDATED FOR SPRING 2021)

Face coverings are mandatory for all faculty and students in the classroom. Students must follow all active UNLV public health directives while enrolled in this class. [UNLV public health directives](https://www.unlv.edu/coronavirus/health-requirements) are found at <https://www.unlv.edu/coronavirus/health-requirements>. Students who do not comply with these directives may be asked to leave the classroom. Refusal to follow the guidelines may result in further disciplinary action according to the [UNLV Student Conduct Code](https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf), https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf, including being administratively withdrawn from the course.

Academic Misconduct

Academic integrity is a legitimate concern for every member of the University community. We all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility, and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy, and are encouraged to always take the ethical path whenever faced with choices. Students enrolling at UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's educational mission. An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another person, from the Internet or any other source without proper citation of the source(s). See the [Student Conduct Code](https://www.unlv.edu/studentconduct/student-conduct), <https://www.unlv.edu/studentconduct/student-conduct>.

Auditing Classes

Auditing a course allows a student to continue attending the lectures and/or laboratories and discussion sessions associated with the course, but the student will not earn a grade for any component of the course. Students who audit a course receive the same educational experience as students taking the course for a grade, but will be excused from exams, assessments, and other evaluative measures that serve the primary purpose of assigning a grade.

Classroom Conduct

Students have a responsibility to conduct themselves in class and in the libraries in ways that do not interfere with the rights of other students to learn, or of instructors to teach. Use of electronic devices such as pagers, cellular phones, or recording devices, or potentially disruptive devices or activities are only permitted with the prior explicit consent of the instructor. The instructor may rescind permission at any time during the class. If a student does not comply with established requirements or obstructs the functioning of the class, the instructor may initiate an administrative withdrawal of the student from the course.

Since the COVID-19 pandemic forced most instruction to be delivered remotely starting on March 2020, numerous students have asked instructors to record their synchronous classes, so that they can access them at their convenience. Instructors who agree to record their classes (audio only, or video and audio) should inform students in advance. Recorded lectures may not be broadly released to anyone, but made available exclusively to those students enrolled in the class during the particular academic term. Recorded lectures must be stored securely, and are subject to the Nevada System of Higher Education's Records Retention Policy, meaning that the recordings can only be deleted 120 days after the end of class (i.e., after grades are posted). Once this requirement is met, the recordings should be deleted. Class recordings are protected from disclosure, as they are deemed part of an educational record under the Family Educational Rights and Privacy Act (FERPA).

Copyright

The University requires all members of the University Community to familiarize themselves with, and to follow copyright and fair use requirements. You are individually and solely responsible for violations of copyright and fair use laws. The University will neither protect nor defend you, nor assume any responsibility for employee or student violations of fair use laws. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional [copyright policy information](https://www.unlv.edu/provost/copyright) is available at <https://www.unlv.edu/provost/copyright>.

Disability Resource Center (DRC)

The [UNLV Disability Resource Center](https://www.unlv.edu/drc) (SSC-A, Room 143, <https://www.unlv.edu/drc>, telephone 702-895-0866) provides resources for students with disabilities. Students who believe that they may need academic accommodations due to injury, disability, or due to pregnancy should contact the DRC as early as possible in the academic term. A Disabilities Specialist will discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours, so that you may work together to develop strategies for implementing the accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor in front of others to discuss your accommodation needs.

Final Examinations

The University requires that final exams given at the end of a course occur on the date and at the time specified in the Final Exam schedule. The Final Exam schedule is typically available at the start of the semester, and the classroom locations are available approximately one month before the end of the semester. See the [Final Exam Schedule](https://www.unlv.edu/registrar/calendars), <https://www.unlv.edu/registrar/calendars>.

Identity Verification in Online Courses

All UNLV students must use their Campus-issued ACE ID and password to log in to WebCampus-Canvas.

UNLV students enrolled in online or hybrid courses are expected to read and adhere to the [Student Academic Misconduct Policy](https://www.unlv.edu/studentconduct/misconduct/policy), <https://www.unlv.edu/studentconduct/misconduct/policy>, which states that “acting or attempting to act as a substitute for another, or using or attempting to use a substitute, in any academic evaluation or assignment” is a form of academic misconduct. Intentionally sharing ACE login credentials with another person may be considered an attempt to use a substitute, and could result in investigation and sanctions, as outlined in the Student Academic Misconduct Policy.

UNLV students enrolled in online courses are also expected to read and adhere to the [Acceptable Use of Computing and Information Technology Resources Policy](https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy), <https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy>, which prohibits sharing university accounts with other persons without authorization.

To the greatest extent possible, all graded assignments and assessments in UNLV online courses should be hosted in WebCampus-Canvas or another UNLV-managed platform that requires ACE login credentials for access.

Incomplete Grades

The grade of “I” (Incomplete) may be granted when a student has satisfactorily completed three-fourths of course work for that semester/session, but cannot complete the last part of the course for reason(s) beyond the student’s control and acceptable to the instructor, and the instructor believes that the student can finish the course without repeating it. For undergraduate courses, the incomplete work must be made up before the end of the following regular semester. Graduate students receiving “I” grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the period indicated, a grade of “F” will be recorded, and the student’s GPA will be adjusted accordingly. Students who are fulfilling an Incomplete grade do not register for the course, but make individual arrangements with the instructor who assigned the “I” grade.

Library Resources

Librarians are available to consult with students on research needs, including developing research topics, finding information, and evaluating sources. To make an appointment with a subject expert for this class, please visit the [Libraries’ Research Consultation](https://guides.library.unlv.edu/appointments/librarian) website, <https://guides.library.unlv.edu/appointments/librarian>. You can also [ask the library staff](#) questions via chat

and text message at <https://ask.library.unlv.edu/>.

Missed Classwork

Any student missing class, quizzes, examinations, or any other class or laboratory work because of observance of religious holidays will be given an opportunity during that semester to make up the missed work. The make-up opportunity will apply to the religious holiday absence only. It is the responsibility of the student to notify the instructor within the first 14 calendar days of the course for Fall and Spring courses (except for modular courses), or within the first 7 calendar days of the course for Summer and modular courses, of their intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit the Missed Work policy, under Registration Policies, on the [Academic Policies](https://catalog.unlv.edu/content.php?catoid=29&navoid=7326) webpage, <https://catalog.unlv.edu/content.php?catoid=29&navoid=7326>.

In accordance with the policy approved by the Faculty Senate regarding missed class time and assignments, students who represent UNLV in any official extracurricular activity will also have the opportunity to make up assignments, provided that the student provides official written notification to the instructor no less than one week prior to the missed class(es).

The spirit and intent of the policy for missed classwork is to offer fair and equitable assessment opportunities to all students, including those representing the University in extracurricular activities. Instructors should consider, for example, that in courses which offer a "Drop one" option for the lowest assignment, quiz, or exam, assigning the student a grade of zero for an excused absence for extracurricular activity is both contrary to the intent of the Faculty Senate's policy, and an infringement on the student's right to complete all work for the course.

This policy will not apply in the event that completing the assignment or administering the examination at an alternate time would impose an undue hardship on the instructor or the University that could be reasonably avoided. There should be a good faith effort by both the instructor and the student to agree to a reasonable resolution. When disagreements regarding this policy arise, decisions can be appealed to the Department Chair/School Director, College/School Dean, and/or the Faculty Senate Academic Standards Committee.

For purposes of definition, extracurricular activities may include, but are not limited to: academic recruitment activities, competitive intercollegiate athletics, fine arts activities, liberal arts competitions, science and engineering competitions, and any other event or activity sanctioned by a College/School Dean, and/or by the Executive Vice President and Provost.

Rebelmail

Rebelmail is UNLV's official email system for students and by University policy, instructors and staff should only send emails to students' Rebelmail accounts. Rebelmail is one of the primary ways in which students receive official University communications, information about deadlines, major Campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the University. Emailing within WebCampus-Canvas is also acceptable.

Tutoring and Coaching

The Academic Success Center (ASC) provides tutoring, academic success coaching, and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, please visit the [ASC website](https://www.unlv.edu/asc), <https://www.unlv.edu/asc>, or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of SSC A, Room 254. Drop-in tutoring is located on the second floor of the Lied Library, and on the second floor of the College of Engineering building (TBE A 207).

One-on-one or small group assistance with writing is available free of charge to UNLV students at the [Writing Center](https://writingcenter.unlv.edu/), <https://writingcenter.unlv.edu/>, located in the Central Desert Complex, Building 3,

Room 301 (CDC 3–301). Walk-in consultations are sometimes available, but students with appointments receive priority assistance. Students may make appointments in person or by calling the Center, telephone 702-895-3908. Students are requested to bring to their appointments their Rebel ID Card, a copy of the instructions for their assignment, and two copies of any writing they have completed on their assignment.

Diversity Statement

As an institution of higher learning, UNLV represents a rich diversity of human beings among its faculty, staff, and students, and is committed to aspiring to maintain a Campus environment that values that diversity. Accordingly, the University supports understanding and appreciation of all members of its community, regardless of race, sex, age, color, national origin, ethnicity, creed, religion, disability, sexual orientation, gender, gender identity, marital status, pregnancy, genetic information, veteran status, or political affiliation. Please see [University Statements and Compliance](https://www.unlv.edu/about/statements-compliance), <https://www.unlv.edu/about/statements-compliance>

A successful learning experience requires mutual respect and trust between the students and the instructor. Accordingly, the instructor asks that students be willing to listen to one another's points of view, acknowledging that there may be disagreements, keep discussion and comments on topic, and use first person, positive language when expressing their perspectives.

Tentative Course Schedule:

JNLV ME 425/625 – Robotics 1 – Fall 2022 (last updated 08/25/22)

Week	Topic								
Week 1 08/29/22	<table border="1"> <tr> <td>Lecture</td> <td>Introduction</td> </tr> <tr> <td>Lab</td> <td>BrixCC setup, NXC programming, Studio</td> </tr> <tr> <td>Homework</td> <td>NXC data types, if-then, loops, TextOut and FormatNum Studio: Casters</td> </tr> </table>	Lecture	Introduction	Lab	BrixCC setup, NXC programming, Studio	Homework	NXC data types, if-then, loops, TextOut and FormatNum Studio: Casters		
Lecture	Introduction								
Lab	BrixCC setup, NXC programming, Studio								
Homework	NXC data types, if-then, loops, TextOut and FormatNum Studio: Casters								
Week 2 09/05/22	Labor Day – UNLV Holiday								
Week 3 09/12/22	<table border="1"> <tr> <td>Lecture</td> <td>Simple Machines I: Levers, Shafts and Cranks</td> </tr> <tr> <td>Lab</td> <td>LEGO levers, shafts and cranks, Domabot</td> </tr> <tr> <td>Programming</td> <td>NXC: strings, motors (OnFwd, Rotate), Buttons, and touch sensor</td> </tr> <tr> <td>Homework Additions</td> <td>NXC: strings, strcount, strnum, etc Domabot touch sensor reaction Studio: Lift mechanisms; Grabbing things</td> </tr> </table>	Lecture	Simple Machines I: Levers, Shafts and Cranks	Lab	LEGO levers, shafts and cranks, Domabot	Programming	NXC: strings, motors (OnFwd, Rotate), Buttons, and touch sensor	Homework Additions	NXC: strings, strcount, strnum, etc Domabot touch sensor reaction Studio: Lift mechanisms; Grabbing things
Lecture	Simple Machines I: Levers, Shafts and Cranks								
Lab	LEGO levers, shafts and cranks, Domabot								
Programming	NXC: strings, motors (OnFwd, Rotate), Buttons, and touch sensor								
Homework Additions	NXC: strings, strcount, strnum, etc Domabot touch sensor reaction Studio: Lift mechanisms; Grabbing things								
Week 4 09/19/22	<table border="1"> <tr> <td>Lecture</td> <td>Simple Machines II: Cams, Springs and Linkages</td> </tr> <tr> <td>Lab</td> <td>LEGO cams, springs and linkages Ultrasonic Docking(no feedback)</td> </tr> <tr> <td>Programming</td> <td>NXC: ultrasonic and infrared</td> </tr> <tr> <td>Homework Additions</td> <td>NXC: Domabot ultrasonic docking (shortest time) Studio: Reciprocating motions</td> </tr> </table>	Lecture	Simple Machines II: Cams, Springs and Linkages	Lab	LEGO cams, springs and linkages Ultrasonic Docking(no feedback)	Programming	NXC: ultrasonic and infrared	Homework Additions	NXC: Domabot ultrasonic docking (shortest time) Studio: Reciprocating motions
Lecture	Simple Machines II: Cams, Springs and Linkages								
Lab	LEGO cams, springs and linkages Ultrasonic Docking(no feedback)								
Programming	NXC: ultrasonic and infrared								
Homework Additions	NXC: Domabot ultrasonic docking (shortest time) Studio: Reciprocating motions								
Week 5 09/26/22	<table border="1"> <tr> <td>Lecture</td> <td>Simple Machines III: Ratchets, Drives and Gearing</td> </tr> <tr> <td>Lab</td> <td>LEGO ratchets, drives and gearing PID ultrasonic docking (with feedback)</td> </tr> <tr> <td>Programming</td> <td>NXC Timers</td> </tr> <tr> <td>Homework Additions</td> <td>NXC: Domabot PID (shortest time) Studio: Gearing and drives</td> </tr> </table>	Lecture	Simple Machines III: Ratchets, Drives and Gearing	Lab	LEGO ratchets, drives and gearing PID ultrasonic docking (with feedback)	Programming	NXC Timers	Homework Additions	NXC: Domabot PID (shortest time) Studio: Gearing and drives
Lecture	Simple Machines III: Ratchets, Drives and Gearing								
Lab	LEGO ratchets, drives and gearing PID ultrasonic docking (with feedback)								
Programming	NXC Timers								
Homework Additions	NXC: Domabot PID (shortest time) Studio: Gearing and drives								
Week 6 10/03/22	Project 1 Relay Race: Introduction								
	<table border="1"> <tr> <td>Lecture/Lab</td> <td>PID and Line Following</td> </tr> <tr> <td>Programming</td> <td>NXC Files</td> </tr> <tr> <td>Homework Additions</td> <td>NXC: Line Following (say in reverse direction) Studio: Ratchets</td> </tr> </table>	Lecture/Lab	PID and Line Following	Programming	NXC Files	Homework Additions	NXC: Line Following (say in reverse direction) Studio: Ratchets		
Lecture/Lab	PID and Line Following								
Programming	NXC Files								
Homework Additions	NXC: Line Following (say in reverse direction) Studio: Ratchets								
Week 7 10/10/22	Project 1 Relay Race: PDR and Practice (No Formal Class)								
Week 8 10/17/22	Project 1 Relay Race: Competition Day								

Week 9 10/24/22	<p>Midterm</p> <p>Part 1 Closed-book (60-min): Fill-in-the-blanks, essays, etc Part 2 Open-book (90-min): Hands-on LEGO construction</p>									
Week 10 10/31/22	<table border="1"> <tr> <td>Lecture</td> <td>Motor Theory</td> </tr> <tr> <td>Lab</td> <td>Motor OL Step Response and Lego Winch</td> </tr> <tr> <td>Programming</td> <td>Arrays</td> </tr> <tr> <td>Homework Additions</td> <td>Motor current, torque and speed curves</td> </tr> </table>	Lecture	Motor Theory	Lab	Motor OL Step Response and Lego Winch	Programming	Arrays	Homework Additions	Motor current, torque and speed curves	
Lecture	Motor Theory									
Lab	Motor OL Step Response and Lego Winch									
Programming	Arrays									
Homework Additions	Motor current, torque and speed curves									
Week 11 11/07/22	<table border="1"> <tr> <td>Lecture</td> <td>Robot Sensing and Actuation: Numbering systems: voltage dividers, and op-amps</td> </tr> <tr> <td>Lab</td> <td>LEGO touch sensor; ohmmeter; potentiometer, voltmeter, and voltage supply (bilib/speaker)</td> </tr> <tr> <td>Homework Additions</td> <td>Light Dependent Resistor</td> </tr> <tr> <td>Prelab</td> <td>PCF8574 circuit</td> </tr> </table>	Lecture	Robot Sensing and Actuation: Numbering systems: voltage dividers, and op-amps	Lab	LEGO touch sensor; ohmmeter; potentiometer, voltmeter, and voltage supply (bilib/speaker)	Homework Additions	Light Dependent Resistor	Prelab	PCF8574 circuit	
Lecture	Robot Sensing and Actuation: Numbering systems: voltage dividers, and op-amps									
Lab	LEGO touch sensor; ohmmeter; potentiometer, voltmeter, and voltage supply (bilib/speaker)									
Homework Additions	Light Dependent Resistor									
Prelab	PCF8574 circuit									
Week 12 11/14/22	<table border="1"> <tr> <td>Lecture</td> <td>Robot Communications: I2C</td> </tr> <tr> <td>Lab</td> <td>LEGO PCF8574 LEDs, DIPs, Relays and Transistors, DC Motors</td> </tr> </table>	Lecture	Robot Communications: I2C	Lab	LEGO PCF8574 LEDs, DIPs, Relays and Transistors, DC Motors					
Lecture	Robot Communications: I2C									
Lab	LEGO PCF8574 LEDs, DIPs, Relays and Transistors, DC Motors									
Week 13 11/21/22	<p>Project 2 Something – Introduction</p> <p>Some ideas: - Tube Push, Photovore, Braitenberg Vehicles, Wall-Following</p>									
Week 14 11/28/22	<p>Project 2 Something – PDR and Practice</p>									
Week 15 12/05/22	<p>Study Week Begins</p> <p>Project 2 Something – Competition Day</p>									
Week 16 12/12/22	<p>Finals Begin</p> <p>Project Due</p>									