

**Autonomous Robots**  
EEL 4930  
**Class Periods:** TBD  
**Location:** TBD  
**Academic Term:** Spring 2022

**Instructor:**

Dr. Christophe Bobda  
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352 294 2024  
Office Hours: TBD

**Teaching Assistant/Peer Mentor/Supervised Teaching Student:**

Please contact through the Canvas website

- TBD

**Course Description**

The design, implementation and operation of autonomous, stationary and mobile robots. Overview of algorithm, sensing and computational components to enable environmental awareness and autonomous mission planning and execution. Credits: 3.

**Course Pre-Requisites**

- EEL4744C- MicroP

**Course Objectives**

To learn theoretical fundamentals and key issues involved in the design and operation of autonomous robots, including robots' parts, motion kinematics and dynamics, simulation testing, sensor incorporation, and unmodeled environmental factors. In group of up 4, students will participate in a project with the goal of designing, building and programming to autonomously perform a given task.

**Materials and Supply Fees**

N/A

**Professional Component (ABET):**

This course consists of 3 credits of fundamentals' understanding, theoretical and practical exercises and final project.

**Relation to Program Outcomes (ABET):**

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	High
3. An ability to communicate effectively with a range of audiences	
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the	

impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

### Required Textbooks and Software

- None

### Recommended Materials

- [Introduction to Autonomous Mobile Robots \(Intelligent Robotics and Autonomous Agents series\) second edition](#) by Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, ISBN-13: 978-0262015356, ISBN-10: 0262015358, The MIT Press; second edition (February 18, 2011)
- [Autonomous Land Vehicles](#), Berns, Karsten/Puttkamer, Ewald von; [Steps towards Service Robots 2009](#). vi, 283 pp. With 246 Fig. and 4 Tab. and 16 algorithms Softc. ISBN: 978-3-8348-0421
- [Introduction to Robotics: Mechanics and Control 4th Edition](#), John Craig, ISBN-13: 978-0133489798, Pearson; 4th edition (February 23, 2017)

### Course Schedule

Week	Class Topic	Outcome
1	Introduction, Problem Statements, Class Organization	<ul style="list-style-type: none"> <li>• Definition of ARs, opportunities, challenges, and applications,</li> <li>• Historical overview and future of Ars,</li> <li>• Class objectives, content organization, syllabus</li> </ul>
2	Robot Systems Components and Integration	<ul style="list-style-type: none"> <li>• Electronics and Computational Platforms,</li> <li>• Close Loop Control,</li> <li>• User interface, Integration, Middleware (ROS),</li> <li>• <i>Homework 1: Computer and control systems</i></li> </ul>
3,4	Locomotion	<ul style="list-style-type: none"> <li>• Legged and wheeled locomotion,</li> <li>• Forward and inverse kinematic,</li> <li>• Wheel types and arrangements,</li> <li>• Degree of mobility and maneuverability,</li> <li>• <i>Homework 2: Kinematics model and trajectory planning and calculation</i></li> </ul>
5	Perception	<ul style="list-style-type: none"> <li>• Introduction, Proprioceptive sensor, exteroceptive sensors,</li> <li>• Encoders, gyroscope, accelerometers, IMU, GPS, range sensors, vision and LiDAR,</li> <li>• <i>Homework 3: Motion control of a differential driven robot</i></li> </ul>
6	Robot Vision 1	<ul style="list-style-type: none"> <li>• Camera basics and calibration,</li> <li>• Stereo vision,</li> <li>• Structure from motion,</li> <li>• Optical flow,</li> </ul>

7,8	Robot Vision 2	<ul style="list-style-type: none"> <li>• Filtering, Image features,</li> <li>• Scene recognition,</li> <li>• Geometric features,</li> <li>• Object recognition,</li> <li>• <i>Homework 4: Camera-based range sensing</i></li> </ul>
9, 10	Localization	<ul style="list-style-type: none"> <li>• Map representation,</li> <li>• Markov localization,</li> <li>• Kalman filter localization</li> </ul>
11	Simultaneous Localization and Mapping (SLAM)	<ul style="list-style-type: none"> <li>• EKF SLAM,</li> <li>• Particle filter SLAM,</li> <li>• GraphSLAM,</li> <li>• MonoSLAM,</li> <li>• <i>Homework 5: Probabilistic localization/SLAM</i></li> </ul>
12	Motion Planning	<ul style="list-style-type: none"> <li>• Problem statement,</li> <li>• Dynamic Programming,</li> <li>• graph construction &amp; Search,</li> <li>• potential Field, randomized search,</li> <li>• <i>Homework 6: Obstacle avoidance on local grid</i></li> </ul>
13, 14	Advanced Topics (Co-Bots, etc...), <i>Optional</i>	<ul style="list-style-type: none"> <li>• Robots in manufacturing, logistic, etc...,</li> <li>• Multi-agent,</li> <li>• Co-bots</li> </ul>
15	Summary	<ul style="list-style-type: none"> <li>• Summary,</li> <li>• Outlook,</li> <li>• Research directions</li> </ul>

### ***Attendance Policy, Class Expectations, and Make-Up Policy***

Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

### ***Evaluation of Grades***

This course is co-listed with the graduate class. The homework portion of the graduate section will involve additional work and more advanced concepts with respect to the undergraduate section. The exams will also involve additional questions for the graduate section with respect to the undergraduate section. The final project will have additional task to design and implement. The graduate and undergraduate sections will be graded separately, for which the graduate section has additional problems and different weights for all problems.

<b>Assignment</b>	<b>Total Points</b>	<b>Percentage of Final Grade</b>
Class Attendance		10%
Homework		50%
Final Exam		20%
Final Project		20%
		100%

- Homework will be mix of theory and coding to practice concepts and tools presented in the class
- Class participation is assessed using random quizzes.
- The final exam will be provided in paper form and will cover the core concepts learned during the semester.
- Parallax' activity bot will be used as robot platform in this course for homework and final project. Students can also purchase or 3D-print parts (wheels and chassis) to assemble the mechanical basis. The sensing

will consist of ultrasound range sensors and a camera on a raspberry PI, Nvidia Jetson, Google TPU or FPGA board.

- Project work will be equally distributed among participating students. The assessment of individual students in a group project will be done according to the level of participation of each student.

### **Grading Policy**

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

### **Students Requiring Accommodations**

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

### **Course Evaluation**

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.ua.ufl.edu/public-results/>.

### **University Honesty Policy**

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### **Commitment to a Safe and Inclusive Learning Environment**

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, [rbielling@eng.ufl.edu](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

### ***Software Use***

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

### ***Student Privacy***

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

### ***Campus Resources:***

#### *Health and Wellness*

##### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

##### **Sexual Discrimination, Harassment, Assault, or Violence**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

##### **Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

#### *Academic Resources*

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** <https://care.dso.ufl.edu>.

**On-Line Students Complaints:** <http://www.distance.ufl.edu/student-complaint-process>.