COURSE OUTLINE

Computer Science/Information Systems 157 Robot Motion Planning

I. <u>Catalog Statement</u>

Computer Science/Information Systems 157 provides an introduction to the art and practice of programming mobile robots using the Python programming language. It uses the context of robot programming to develop skills in software development; no programming prerequisites are necessary. Students gain experience specifying open-loop and feedback behaviors, handling RGB input video, range images, tactile sensing, and other robot sensors, and reasoning about the spatial context of navigation and localization tasks. The vast majority of the course experience consists of implementation of and experimentation with these skills through hands-on labs.

Total Lecture Units: 2.0 Total Laboratory Units: 1.0 **Total Course Units: 3.0**

Total Lecture Hours: 32.0 Total Laboratory Hours: 48.0 **Total Faculty Contact Hours: 80**

Prerequisite: None.

II. <u>Course Entry Expectations</u>

Skill Level Ranges: Reading 5; Writing 4; Listening/Speaking 5; Math 4.

III. Course Exit Standards

Upon successful completion of the required coursework, the student will be able to:

- 1. design and implement Python programs that solve algorithmic and robotic problems;
- 2. compose software that will control a mobile robot to complete navigation tasks successfully, including the integration of sensing, sensor-data processing, and robot action;
- 3. articulate and mitigate the challenges that distinguish robot programming both from the human performance of tasks and from programmatic solutions to non-robotic tasks.

Course Content IV.

Total Faculty Contact Hours = 80

	A.	 Programming Robot Motions/Actuation 1. Ground-platform programming a. Differential-drive geometry and constraints b. Arcade-style vs. individual-wheel control 2. Aerial platform programming a. Strategies for stabilizing motions b. Holonomic robot control 3. Control techniques a. Open-loop control b. Direct-feedback control (servoing) c. State-machine control 	Lecture 10 hours Lab 15 hours
	B.	Processing Sensor Data	Lecture 10 hours
		 Infrared data (e.g. for line-following or single-range sensing) Tactile (bump) sensing RGB video data 	Lab 15 hours
		b. Region segmentation and image morphology	
		 c. Statistical summaries: center of mass and bounding box A Bange image data 	
		 a. 2d and 3d estimation of planar surface/wall geometry b. Handling angles without a privileged coordinate system c. 2d segmentation of 3d range data 	
	C.	Robotic Spatial Reasoning	Lecture 12 hours
		 Designing robot tasks through purely reactive control Using state machines to add context to robot tasks 	Lab 18 hours
		3. Implementing navigation algorithms	
		a. Using human-specified destinations b. Using sensor-specified destinations	
		c. Robust motion planning to handle environmental uncertainty	
		a. Environment-specific localization	
		b. Monte Carlo techniques for localization	
V.	<u>Metho</u>	ds of Instruction	
The following instructional methodologies may be used in the course:			
1. lecture and demonstration;			

- instructor and peer analysis of student work;
 individual instructor-to-student assistance in the class.

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VI. Out of Class Assignments

The following out of class assignments may be used in the course:

1. individual and/or group project (e.g. develop and deploy software solutions to robot challenges).

VII. <u>Methods of Evaluation</u>

The following methods of evaluation may be used in the course:

- 1. midterm examinations and quizzes;
- 2. performance-based assessment of student-written programs;
- 3. instructor evaluation of student portfolio work;
- 4. final examination.

VII. <u>Textbook</u>

 Siegwart, Roland, Nourbakhsh, Illah, and Scaramuzza, Davide. *Introduction to Autonomous Mobile Robots*. Second Edition. Cambridge, MA: MIT Press, 2011.
 13th Grade Textbook Reading Level. ISBN-13: 978-0-262-01535-6.

Choset, Howie, Lynch, Kevin, Hutchinson, Seth, Kantor, George, Burgard, Wolfram, Kavraki, Lydia, and Thrun, Sebastian. *Principles of Robot Motion*. Cambridge, MA: The MIT Press, 2005.

13th Grade Reading Level. ISBN-13: 9-780262-033275.

VIII. <u>Student Learning Outcomes</u>

Upon successful of the required coursework, the student will be able to:

- 1. Students will design and implement Python programs that solve algorithmic and robotic problems.
- 2. Students will compose software that will control a mobile robot to complete navigation tasks successfully, including the integration of sensing, sensor-data processing, and robot action.
- 3. Students will articulate and mitigate the challenges that distinguish robot programming both from the human performance of tasks and from programmatic solutions to non-robotic tasks.