CSCI–4190 Introduction to Robotic Algorithms
Spring 2006

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office hours:	TBA (M 1/23 3-5)	office hours:	TBA

classroom:	VCC South
times:	Mondays and Thursdays, 10:00 - 11:50
prerequisites:	CSCI–2300 Data Structures and Algorithms
	MATH–1020 Calculus II
	MATH–2800 Introduction to Discrete Structures
text:	none (course notes)
WWW:	http://www.cs.rpi.edu/academics/courses/spring06/ira
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1 Course description

This course is an introduction to algorithms for robotic systems. The theme of the course is how these algorithms intelligently make use of sensory information from their environment and purposefully act upon it. Topics will include motion planning, processing sensor information, localization, mapping, and handling uncertainty. We will discuss applications in mobile robotics and in robotic manipulation. There is a laboratory component of this class in which students will implement a number of these algorithms on mobile robots.

2 Course activities

Since robotics is about developing algorithms and theory to give robots certain capabilities, the course activities span the range from algorithms and theory to implementation on robot hardware.

2.1 Assignments

There are three assignments in this class; they will focus on implementing some general algorithm in software (only). The assignments will involve writing a program in C++, but there will also be some written component. The assignments are to be done individually; each will be approximately 2.5 weeks long. Assignments are due on Mondays.

2.2 Final project

You will do a final project in teams of 2–3 students. This project must combine at least two aspects from the class (e.g. mapping and localization, or motion planning and control) and must involve implementation on the robot in my lab. You will have some choice for your final project topic.

2.3 Labs

There are four labs on the tentative schedule; the labs will focus on programs that will control a mobile robot to do a specific task. My intention is for the labs to be reasonably short and self contained. There will be a 2 week period in which you must complete the lab.

The first lab will be a "supervised lab," so you will need to arrange a lab time with the TA. For the remaining labs, you will be able to use the lab anytime, but you will have to arrange to demonstrate your results to the TA.

2.4 Quizzes

There are quizzes on every other Monday. These are intended to be relatively short and to test the material that we have covered in the past two weeks. Towards the end of the semester, I might turn one or more of these into a "take-home quiz." I will drop the lowest quiz score from the quiz component of your grade. There are no make-up quizzes, so you must attend class to take them.

2.5 In-class exercises

I expect to give some number of (unannounced) in-class exercises. These will ask you to solve a problem, and we will go over solutions right away. I have typically used the exercises to determine a small "bonus factor" for your final grade.

3 Grading

Your grade will be determined according to the following (tentative) breakdown:

30%	Assignments
25%	Final project
20%	Labs
25%	Quizzes

4 Resources

We will be making use of the course home page and WebCT during the semester. Many (but not all) handouts will be available online through this page.

There will be a number of items placed on reserve at the library. The course home page will contain a list of these items.

The instructor and TA will hold regular office hours; you can feel free to drop in during these times. You may also make an appointment to see the instructor or TA outside of these times. We will try to keep the course web page updated with our current office hours.

5 Course policies

The following policies will be clarified as necessary during the semester and will be revised if necessary. The course home page will be updated with the current versions.

5.1 Academic honesty

I expect any assignment, lab, exercise, reading report, quiz, or final project that you turn in to be your own work (with your partner/team when appropriate) — the product of your understanding of the course material and your own efforts in completing the activity. More specifically, it is inappropriate to give or receive code for an assignment to or from anyone else. The same applies to the labs and final project except that you will of course be working with a lab partner and final project team.

The Rensselaer Handbook of Student Rights and Responsibilities defines several types of academic dishonesty, all of which are applicable to this class. Students found in violation of academic dishonesty policies may receive a failing grade for this course.

Please contact the instructor if there is any question about academic (dis)honesty.

5.2 Late work

By default, everything in this class is due at the beginning of class (10:00) on the day it is due. However, I will usually collect written work during the break (i.e., in the middle of class).

Late work places an additional burden on the teaching staff and is unfair to those students who turn in their work on time. It also tends to delay the grading process. However, I do want to encourage students to complete work for a short period after the deadline.

Unless you make *prior* arrangements with the instructor, late work is subject to late penalties. I am planning to use a two-tier system with flat late penalties. For an assignment or lab due Thursday:

- the first-tier deadline is Friday at 5pm, and the corresponding late penalty is 7.5%
- the second-tier deadline is Monday at 10am, and the corresponding late penalty is 15%

Different components of an assignment or lab will often be treated separately under this late policy.

5.3 Attendance

You are expected to attend class prepared to discuss or answer questions on previously covered material.

5.4 Excuses

If there is some good reason that you will need an extension on any assignment, exercises, etc., contact me *in advance*. If you do not contact me in advance, I will ask you to get a letter from the Dean of Students. They will verify excuses (typically illness, family emergency, etc.) and write a memo. This way I can be assured of a valid excuse without needing to know details of students' personal lives.

5.5 Grading appeals

If you disagree with the grading on an assignment, exercise, etc., I will ask you to appeal first to whoever graded it (often the TA) so that consistency over the class is maintained. Should you appeal a grade to the TA and are unsatisfied with the outcome, then see the instructor. Appeals must be made within two weeks after the work is returned.

5.6 Changes

There may be changes to the policies, deadlines, and schedule described in this syllabus. You can expect me to give you reasonable notice of any changes. All changes will be announced in class and appear on the course web page or WebCT.

6 Tentative Schedule

Week		Date		Topic	Quiz	Assign	Labs
1	R	Jan	19	Introduction; Mobile robot hardware			
2	M	Jan	23	Control: dynamics of physical systems		A1 out	L1 out
	R	Jan	26	Control: basic feedback control			
3	M	Jan	30	Control: basic feedback control	Q1		
	R	Feb	2	Sensing: sensors & sensor interpretation			L1 due
4	M	Feb	6	Navigation: local navigation methods			L2 out
	R	Feb	9	Navigation: online motion planning methods		A1 due	
5	M	Feb	13	Navigation: online motion planning methods	Q2	A2 out	
	R	Feb	16	Localization: intro, least squares estimation			L2 due
6	T	Feb	21	Localization: least squares estimation			L3 out
	R	Feb	23	Localization: Kalman filter			
7	M	Feb	27	Localization: Kalman filter	Q3		
	R	Mar	2	Localization: Markov localization		A2 due	
8	M	Mar	6	Mapping: intro, representation			
	R	Mar	9	Mapping: basic mapping			L3 due
	M	Mar	13	NO CLASS — spring break			
	R	Mar	16	NO CLASS — spring break			
9	M	Mar	20	Mapping: SLAM	Q4	A3 out	L4 out
	R	Mar	23	Mapping: SLAM			
10	M	Mar	27	Mapping: SLAM			
	R	Mar	30	Motion planning: intro, C-space			L4 due
11	M	Apr	3	Motion planning: cellular decompositions	Q5		
	R	Apr	6	Motion planning: roadmap methods		A3 due	
12	M	Apr	10	Motion planning: sampling methods			
	R	Apr	13	Motion planning: nonholonomic methods			
13	M	Apr	17	Architectures: intro, deliberative architectures	Q6		
	R	Apr	20	Architectures: reactive & hybrid architectures			
14	M	Apr	24	Computer Vision			
	R	Apr	27	Computer Vision			
15	M	May	1	TBA	Q7		