CSCI–4190 Introduction to Robotic Algorithms
Spring 2003

Instructor:	Prof. Wes Huang	TA:	Kris Beevers
email:	whuang@cs.rpi.edu	email:	beevek@cs.rpi.edu
office:	Amos Eaton 111, x8189	office:	Lally 009
office hours:	Wed. 4:30 - 6:00 (or by appointment)	office hours:	Mon. 1:00 - 2:00 (or by appointment)

classroom:	Darrin 236
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)
optional text:	Dudek and Jenkin, "Computational Principles of Mobile Robotics"
www:	http://www.cs.rpi.edu/courses/spring03/robotic
secretary:	Shannon Bornt <bornts@cs.rpi.edu>, Amos Eaton 132

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

There are a variety of activities for this course: (programming) assignments, labs, quizzes, exercises, reading reports, and a final project. While this is a lot of different activities, I am committed to keeping the workload for this class at a reasonable level. I have taken some care to schedule these activities so that there are never two things due at once and to maintain the focus of the class.

Sometime before spring break, I will survey the class for feedback on the course activities, but I would welcome feedback at any time.

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, and you will have 2.5 weeks (or more) to complete each one. Assignments are due on Mondays (except for the one due the week after spring break).

There will be various libraries or support code you will have to use for these assignments. In particular, there will be a library for graphical display, a library for reading configuration files, and the CGAL computational geometry algorithms library. The first two are libraries we have written, and the last is available free for academic use.

A word on computing/programming environments: We will support SunOS (UNIX) on the CS department machines and Linux. FreeBSD and MacOS support is uncertain. We expect to support Windows with the caveat that you will be responsible for installing the CGAL library yourself. There are two possible disadvantages to using Windows: we may

require that your compile and code run under SunOS, and you will have to program in a UNIX environment for the labs and final project.

2.2 Labs

There are four labs on the tentative schedule; the labs will focus on programs that will control a mobile robot in my lab to do a specific task. My intention is for the labs to be reasonably short and self contained. You and your lab partner will have to arrange for a time outside of class to demonstrate your results in the lab, either to me or a TA. There will be a 2–3 week period in which you must complete the lab.

2.3 Quizzes

There are six quizzes on the tentative schedule; these will be short (15–25 minute) and are intended to reinforce material that we have been covering in class. Quizzes are scheduled for Mondays but never in the week that an assignment is due.

The topics (and date) of each quiz will be announced one week in advance. There are no makeup quizzes! If for some reason you have a very good reason for missing a quiz, contact me *in advance*. After a quiz is given, I will only except a very very good reason, verified by the Dean of Students.

2.4 Exercises & reading reports

In order to reinforce material covered in class or for students to develop a better understanding of some topic, I will assign a small number of exercises on approximately a weekly basis. I expect the amount of time to do these exercises to vary: some weeks, they may only take a half hour, but on other weeks they may take longer. These exercises will be due on Thursdays.

Stating sometime mid-semester, I will assign a reading report instead of exercises. This will involve reading a research paper from some robotics conference and writing a short summary and critique.

2.5 Final project

You will do a final project in teams of 2–3 students. The topic of this project will be self-selected, with my approval; however, I will also suggest a number of topics. There are five weeks for working on the final project after Assignment 3 is due.

3 Grading

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

35%	Assignments
15%	Labs
20%	Exercises & reading reports
15%	Quizzes
15%	Final project

You must "pass" at least half the assignments and labs in order to receive a passing grade for this class.

4 Resources

We will be making extensive 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.

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 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

Late work places an additional burden on the teaching staff and is unfair to those students who turn in their work on time.

Unless you make *prior* arrangements with the instructor, assignments and exercises are due at the beginning of class (10:00) on the day they are due.

For assignments, there will be a two tier system with flat late penalties. Late work turned in anytime before the first tier deadline is assessed a 7.5% late penalty. Late work turned in after the first tier deadline but before the second tier deadline is assessed a 15% late penalty. Late work is not accepted after the second tier deadline. The late period deadlines will be specified with each assignment.

Exercises and labs will have a slightly different late policy which will be clarified when the first of each is handed out.

5.3 Attendance

You are expected to attend class prepared to discuss or answer questions on previously covered material. Since there are no make-up quizzes, you must attend class to take the quizzes.

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 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 assignment, exercise, etc. 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	M	Jan	13	Introduction; Mobile robot hardware			
	R	Jan	16	Mobile robot hardware		A1 out	L1 out
2	M	Jan	20	NO CLASS — Martin Luther King, Jr. Day			
	R	Jan	23	Motion planning: intro, C-space			
3	M	Jan	27	Motion planning: cellular decompositions	Q1		
	R	Jan	30	Motion planning: roadmap methods			L1 due
4	M	Feb	3	Motion planning: potential fields		A1 due	L2 out
	R	Feb	6	Motion planning: randomized methods		A2 out	
5	M	Feb	10	Motion planning: online motion planning	Q2		
	R	Feb	13	Sensing: introduction			L2 due
6	T	Feb	18	Sensing: wheels, encoders, odometry	Q3		L3 out
	R	Feb	20	Sensing: least squares estimation			
7	M	Feb	24	Sensing: localization		A2 due	
	R	Feb	27	Sensing: Kalman filtering		A3 out	
8	M	Mar	3	Sensing: IR sensors	Q4		
	R	Mar	6	Sensing: SONARsensors			L3 due
	M	Mar	10	NO CLASS — spring break			
	R	Mar	13	NO CLASS — spring break			
9	M	Mar	17	Mapping: world representation & modeling			L4 out
	R	Mar	20	Mapping: SONAR mapping		A3 due	
10	M	Mar	24	Mapping: SONAR mapping	Q5		
	R	Mar	27	Control: dynamics of physical systems			
11	M	Mar	31	Control: basic feedback control			
	R	Apr	3	Architectures: introduction			L4 due
12	M	Apr	7	Architectures: deliberative	Q6		
	R	Apr	10	Architectures: reactive			
13	M	Apr	14	Architectures: hybrid			
	R	Apr	17	Manipulation			
14	M	Apr	21	Computer Vision			
	R	Apr	24	Nonholonomic motion planning			
15	M	Apr	28	TBA			