Chapter 1

Introduction to 6.270

6.270 is a hands-on, learn-by-doing class in which participants design and build a robot that will play in a competition at the end of IAP. The goal for the students is to design a machine that will be able to navigate its way around the playing surface, recognize other opponents, and manipulate game objects. Unlike the machines in Introduction to Design (2.70), 6.270 robots are totally autonomous, so once a round begins, there is no human intervention (in 2.70 the machines are controlled by joystick).

The goal of 6.270 is to teach students about robotic design by giving them the hardware, software, and information they need to design, build, and debug their own robot. The subject includes concepts and applications that are related to various MIT classes (e.g. 6.001, 6.002, 6.004, and 2.70). **But:** There are no formal prerequisites for 6.270. We've found that people can learn everything they need to know by working with each other, being introduced to some material in class, and mostly, by hacking on their robots. All members of the MIT community, from frosh to grad students, staff, or even professors, are encouraged to register and take the class.

One caveat: 6.270 does require that you be psyched to put forth a real effort! We expect most students to spend about eighty hours over the month of IAP building their robots. Other commitments during the month of IAP are not recommended. We've also noticed that people who make a real commitment to the class are more confident, feel more involved, and have a lot more fun. So, if you going to take 6.270, be ready for a month-long immersion into robotics!

1.1 Registration Policy

Registration in the class is limited to fifty (50) teams. We would accept more students if resources permitted, but they do not.

All entrants will be organized into teams. There are a couple of reasons for this. First, we find that people learn a lot in the close and intense relationship of a small

team. Second, we think the class would be too much work for one person to handle alone.

This class will take up enough of your time that you will not be able to work on other projects such as another course, UROP, or Thesis. Past students that have tried to do several time consuming projects have usually dropped out of the subject, or have not been able to produce a working robot. This year the duration of the subject will be shorter than past years because of the shortening of the IAP period so it is especially important you estimate the amount of time you will have before registering.

You are encouraged to form a team of two to three people and register together. You may also register alone, in which case we will find you a team with two other people.

1.2 Kit Fee and Toolkit Fee

Your 6.270 kit, which is yours to keep at the end of the contest, will valued at about $500. The class is mostly financed by our commercial sponsors (namely Microsoft, Motorola, LEGO, Gates, and Polaroid) and Course Six, but part of the budget is derived from the entry fee.

The team will be required to forfeit the kit back to the EECS department if it fails to present something to the organizers by the preliminary round of the contest (January 25, 1993). Teams that do not return their kit once it is forfeited, or loses their kit will be charged the full $750 for the kit through the Bursar's office.

Separate from the 6.270 kit, a complete set of electronic hand tools will be reserved for purchase by your team. This kit will include a soldering iron, diagonal cutters, long nose pliers, wire strippers, a multimeter, and several other useful implements.

The 6.270 tool kit will have a retail value between $75 and $100; we expect to sell the kits for between $50 and $60 (we can give you these prices due to the quantity discounts we get in purchasing for the class). *You will be expected to either provide your own electronic assembly tools or purchase the standard tool kit.* It is very important that you have a good set of tools to work with. You will save many hours of debugging and frustration if you use good tools and assemble the material carefully. A sharp tipped soldering iron is essential to assembling your microprocessor board.

A final word about contest costs: if it is difficult for you to afford the contest costs, both the 6.270 kit and the toolkit are returnable (if in good condition) for a refund. If you would like to take the class, but you cannot afford to put up the money to register for the class and buy the toolkit, come talk to the organizers. We can probably work something out. Cost should not be a factor in determining whether you are able to take the course.

1.3 Credit Guidelines

6.270 is offered as MIT subject 6.190 for six units of P/F credit. Taking the class for credit is optional. You will be doing a lot of work in the class regardless; if you sign up for credit you will get official recognition for taking the class. If you sign up for credit but then do not complete the requirement, your registration will be dropped; it will be as if you never signed up in the first place.

Our job as instructors is to ensure that credit is properly awarded to students deserving of it. Our basic assumption is that anyone who is in the class is going to be doing a lot of work; the guidelines should add only a little bit of overhead to you in reporting your work to us. Hopefully, you may even learn a little more by going through the process of reporting on your progress.

As mentioned in the registration guidelines, team size for students registering for credit will be limited to two or three members. This is because of our observation that it's very hard for a team of four members to fairly distribute work amongst themselves. It is also a very difficult job to determine how to award credit for teams with four members.

1.3.1 Credit Guidelines

The following requirements for credit have been established:

- **Individual Journal Reports.**

  Each individual desiring credit must turn in a journal report that will be due on January 25th. The journals are meant to help you with your thought processes. You should try to make an entry every day or every other day. The journals should include:

  - ideas that you have contributed to the development of the robot;
  - what management techniques your team is using;
  - strategies you have thought of;
  - problems you have encountered;
  - actual construction work, programming, or other tangible results.

  These ideas are examples of thoughts you might include. You are free to include anything else you would like to include. Pictures are a good way to try to convey your ideas and for reference.

  After the contest is over, you can pick up your journals to think about your ideas.

The purpose of the individual journal is to get a sense of what each person on a team is contributing to the design, so it's important to make sure we know what you've done.

- **Team Video Reports.**

  In addition to the individual reports, a team video report will be made once per week.

  A video station will be set up in the 6.270 lab area. To make your report, you and your team can simply go to the camera and make a brief presentation on the status of your robot. This presentation should focus on issues that the team has worked on together, such as the current state of the robot, the strategy of the robot, and how the team arrived at consensus (or not!) on particular issues.

  Hopefully, the video station concept will make the design reporting a fun and painless process. Any ideas presented to the camera *will remain confidential* for the duration of the contest.

- **Team Interview.** During the final week of IAP, your team will have the opportunity to meet with the contest organizers to discuss your participation in the class: what you learned, what you didn't learn, what you liked about it, what you didn't like.

  The interview serves as an opportunity for you to give us (the organizers) feedback about the course and your learning experience so that we can continue to improve the class format. The team interviews will be on a voluntary basis, but they are encouraged.

- **Completed Robot.** Your team must "show" a robot the day of the preliminary contest. Its functionality (or lack of) has no affect on your receiving credit for the work you have done; the combination of the individual journals, the video reports, and class participation will be the main indicators of your involvement.

  The contest is on January 26th. We'll see your robot there.

- **Program Listing.** You must turn in a copy of the program that your robot uses in the contest.

These subject requirements are meant to be useful to both you, the class participant, and the instructors, who will be authorizing credit. You should have no problem at all receiving credit if all of the requirements are satisfied. If you have any questions about your standing in the subject at any time, feel free to ask any of the instructors for feedback.

Please note that there is no leeway on any of the due dates, due to the scheduling constraints of the Registrar and the sanity of the organizers. Please do not ask for extensions.

1.3.2 Design Units

Since design is an important factor in 6.270, the EECS department will be offereing 6 design units for EECS students that take 6.270. There are some guidelines and requirements for getting the design units.

First you must complete all the requirement to get credit for the course. It will come on your transcript. At the end of the contest, you must do an evaluation of your robot. In all design processes there should be some type of evaluation and redsign. You will need to submit a 5-10 page paper. The paper should include, but not be limited by the following:

- An overall summary of your robot. This could include pictures or drawings.
- An evaluation of your robot's performance.
- Your individual redsign of the robot. If you were given an opportunity to retake the course with the same goals how would you make your robot different?
- Possible design flaws in the goals of the contest.

This paper should be submitted by January 30th to the EECS undergraduate office. The papers should be your individual evaluations, and not a general group evaluation.

1.4 Schedule

The schedule of activities between the start of IAP and the eve of the contest is very tight. You will have to work steadily and with determination to produce a working machine by the end of the course. In no fashion do we, the contest organizers, say that this course is not time consuming! In fact, we believe that you should be spending somewhere between 30 and 40 hours a week on average. However, since it is IAP, we can assume it is the main timesink you've signed up for.

There will be about 150 students taking the 1994 6.270 course, making it one of the largest courses taught during IAP. Since much of the learning we believe, occurs with hands-on instruction, the class will be too large as a whole to teach on this basis. Therefore we have several class meeting formats, including lectures, recitations, lab demos, and lab sessions.

We recommend that you attend all of the lectures and recitations (for the section you are in) and **be on time**. We will deal with administrative and "bug fix" matters at the beginning of each meeting.

To make the course more personal, each organizer and TA will be the primary advisor for about 10 teams. The TA and organizer pair will be similar to the recitation instructor and TA pair you have in your normal classes. While these people are your primary advisors, you can approach anyone with questions you may have.

It is imperative that you check your E-mail often. Most notices will be posted through electronic mail. In addition, we will mention these notices in labs and lectures. You should check your mail at least once a day, if not more. This is the best way we can get in touch with the whole class on short notice.

- **General Lectures** The objective of the general lectures is to introduce you to the basics of the course. These sessions will try to give you an overview of the course and what you will be doing. The lectures will take place during the first week of the course. Since the students in this class typically have widely varying experience with the material, we will try to keep the lectures as general as possible.

  The lectures will also show you where to find advanced topics and more detailed answers for ambitious teams. There will be five basic lectures, from two to three hours each, to be held in 34-101. Check the schedule below for times and dates. It is important that you attend these lectures because they will give you the essential starting blocks.

- **Catch-Up IC Session** This is a general lecture for students who have had no C programming experience. We will go over the basics of the C language in particular how it applies to the IC language which will be used in the course. The main purpose of this lecture is to introduce basic concepts like variables, functions, and syntax. The lecture will be held in 34-101 on Thursday, January 6th at 12:00 PM.

- **Recitations** Detailed material will be presented in recitations rather than in lectures, to encourage a more interactive format. There will be several recitation sections, led by someone who has already taken 6.270 so they can tell you about their experiences and how to avoid the 6.270 pitfalls. The recitation leader will usually be one of your TA's or an organizer.

  The size of the recitation will be between 5 and 6 teams. The recitations are meant for group discussions, thinking about problems, sharing ideas, and experimenting. Many of the recitations will have hands-on experiments and will require you to have built sensors and motors.

Recitations will be held during the second and third weeks of January. There will be two recitations per week. The schedule for the recitations will be discussed during the first lecture.

- **Laboratory Sessions** This is supervised time for building your robot. Lab time will be critical when working on your microprocessor and other circuit boards. After that, building motors and sensors will be important. During the final week, testing machines on the table will be the focus of lab activity.

  There will be smaller lab discussions where the TA's will give ideas on mounting sensors, soldering, programming, and general construction. It is also a good idea to use the lab facilities because there will be people there who can help you with your ideas. One of the goals of 6.270 is to teach interactively, and by working in the labs you will be able to share ideas with other people and experiment with ideas you may not have thought of.

  Labs will be held on the 6th floor of building 38. They will be open from 10:00 AM to 11:00 PM during the weekdays, and 10:00 AM to 4:00 PM on Saturday. The final two days of the course, the labs may be open 24 hours.

1.4.1 Important Dates

Before reading the listing of the full month of meetings, please note the following *very important* meetings:

Parts-Sorting Session. Attendance at this session is mandatory: all teams must provide four person-hours of manual labor helping to sort out the kit parts. Usually this session is a lot of fun as you get to meet other people in the class and see all of the electronic goodies.

Date, Time, and Place: Sunday, January 2rd, 1:00 pm to 5:00 pm, Room 38-201 (The Chu Lounge).

Official Orientation Meeting. Attendance at this session is mandatory: each team must have at least 50% of its members in attendance. In this session, we will go over the contest rules and organization of the class, and hand out the kits.

Date, Time, and Place: Monday, January 3th, 10:00 am to 1:00 pm, Room 34-101.

The Contest, First Round. Your machine must compete in the first round to qualify for the second round.

Date, Time, and Place: Sunday, January 23th, 6:00 pm, Room 34-101.

Robot Impounding. All work on robots will cease one day after the first round. All robots, including the ones that haven't made it past the seond round will be impounded at *The Chu Lounge, 38-201.*

Date, Time, and Place: Monday, January 24th, 7:00 pm, Room 38-201.

The Contest, Second Round Tuesday, January 25th, 11:00am, Room 26-100 The second round of the double elimination contest will take place. There should be TV cameras to cover the event for local TV.

The Contest, Final Rounds. Robots will be released from impoundment at 3:00 pm, on Tuesday January 25th. You must check your robot into 26-100 by 4:30 pm. Good luck!

Date, Time, and Place: Tuesday, January 26th, 6:00 pm, Room 26-100.

1.4.2 Progress Schedule

This year the time allocated for the 6.270 course is shorter than in previous years. There are only 20 days between the day you get your kit and the preliminary contest. It is therefore imperative that you set a personal schedule with goals before you begin the course. You may want to distribute the work among the team members in order to optimize team productivity.

Here is a checklist of important tasks you will need to do in order to make a working robot with the completion dates to prevent end of IAP stress:

- ◯ **Course Notes** Read the Course notes as soon as possible. All of the details covered in class will be in the course notes. They contain the administrative material as well. You should read this by the end of the first week, **Friday, January 8th.** If you come and ask us a question without reading the notes, we will be more hesitant to answer your question.

- ◯ **Microprocessor Board** The assembly of the microprocessor board should take between 10-15 hours for someone who has not soldered before. You should complete soldering by the morning of **Wednesday, January 5th.**

- ◯ **Sensor Assembly** You should assemble your sensors early so that you can play around with them. This will take you about one day. Soldering the sensors together and testing their properties should be done by **Friday, January 7th.**

- ◯ **Motor Assembly** You should "LEGOize" at least two motors so you can build a simple bot. By building a simple gearing mechanism early, you can test out the properties of the motor such as the torque and speed. We expect you to have simple gear assemblies being controlled by the microprocessor board by the evening of **Friday, January 7th.**

- **Simple Tasks** While you are formulating your strategy, your robot will need to do some simple tasks depending on the contest. You should use your simple bot and sensors to program these tasks. The tasks will be discussed in recitation. You should formulate your strategy, depending on how easy these task are. The tasks should be tested by **Monday, January 12th.**

- **Strategy** By the beginning to the middle of the second week your team should formulate a strategy for your robot. In the past teams have spent many days pondering over strategies. The indecisiveness usually leads to panic during the last week. You should get a strategy and stick with it rather than trying to restructure your strategy every day. To be at a reasonable pace, without too much stress at the end, you should have a defined strategy by **Monday, January 12th.**

- **Structure of Robot** During the first week, your team should "fool around" with the LEGO to get familiar with the structural properties. Once you have decided upon a strategy, you should complete the actual robot, with motor attachments and sensors by **Thursday, January 13th.**

- **Programming** This is where you will have to tie everything together. You will need to combine your strategy, sensors, and robot to make the robot do what you want it to do. Do not underestimate the amount of time needed for this activity. Hopefully the simple tasks that you had a simple robot do during the first week will fit into your strategy. Complete your basic program by **Tuesday, January 18th.**

- **Debugging and Testing.** Your code probably won't work perfectly the first time you try it out. You should spend a few days testing out the machine and fixing any quirks it may have. This will be the long and tedious process of fine tuning your machine. By **Friday, January 21nd,** you should have a pretty robust machine.

- **Mock Contest** We will hold a mock contest on the evening of **Saturday, January 22rd** so that you can see how your machine performs against other machines. It is advisable to try your machine against other machines before this day.

- **Final Revisions** The final fine tuning of the machines can be done on **Saturday, January 22rd.**

Many of the teams that have done well in the past have been teams that have completed a final design and strategy early, and have left time to debug the machine. When the course was four weeks long, teams have had the tendency to take the second

week off because they felt they were ahead, and that programming would be a cinch. This year there is no second week, and you should be prepared to stay the course.

1.4.3 Detailed Schedule of the Month's Activities.

Sunday, January 2. Part-Sorting Meeting. *1:00p to 5:00p, 38-201.* Sort kits. Mandatory attendance as mentioned above.

Monday, January 3, 10:00a to 1:00p.

- **First meeting.** *10:00a to 1:00p, 34-101.* Hand out kits, go over month's schedule, go over rules, get psyched.
- **Lab.** *2:00p to 4:00p, 38-601* Sell tool kits, go over soldering techniques in smaller groups.
- **Lab.** *7:00p to 10:00p, 34-101* Continue working on assembling your boards aftre dinner. Don't slack off.

Tuesday, January 4.

- **Lab.** *10:00a to 2:00p, 38-601* Supervised lab time. Continue building microprocessor board! Soldering demonstrations at 10:00 and 12:00.
- **Lecture #2.** *3:00p to 5:00p, 34-101.* Go over some of the simple strategies involved in the contest. Brainstorm some ideas, and demos.
- **Lab.** *7:00a to 11:00p, 38-601* Finish up your microprocessor board and begin soldering up sensors and putting together motors.

Wednesday, January 5.

- **Lab.** *10:00a to 2:00p, 38-601* Supervised lab time. Finish building microprocessor board! Start playing with the sensors you have built.
- **Lecture #3** *3:00p to 5:00p, 34-101.* Introduction to sensors, learn about the powerfulness of the Gates Batteries, simple motor and gearing information, learn about the importance of correct structural design with the LEGOs, and take a break for dinner before the LEGO lab. Students can choose the TA section they would like to be in.
- LEGO Lab *Section 1 – 7:00p to 8:00p; Section 2 – 8:00p to 9:00p, Location TBA* Workshop for building LEGO projects to help with structural problems.
- **Lab.** *7:00a to 11:00p, 38-601* Supervised Lab. Work on your motors and sensors.

Thursday, January 6.

- **Introduction to C Programming.** *10:00a to 11:00a, 34-101* This lecture will introduce to the "C" programming to people who have never used it. Explanation of variables, functions, and basic C syntax that will be applicable to the IC programming language.

- **Lab.** *9:30a to 11:00p, 6th floor of bldg. 38.* Supervised lab time. Finish soldering the microprocessor board; begin testing it.

- **Lecture #4.** *3:00p to 5:00p, 34-101.* Introduction to 6811 C environment. Simple control of motors, sensors, and LCD commands. Overview of multitasking capabilities and the IC libraries. Simple code to let you begin programming your finished boards. Filtering sensor data in software.

- **Lab.** *7:00p to 11:00p, 6th floor of bldg. 38.* Supervised lab time. Finish sensors, motors, simple robots; begin programming simple tasks. Several sensor and motor mounting demonstrations.

January 7.

- **Lab.** *10:00a to 11:00p, 6th floor of bldg. 38.* Supervised lab time. Finish sensors, motors, simple robots; begin programming simple tasks. Several sensor and motor mounting demonstrations.

Saturday, January 8.

- **Lab.** *10:00a to 4:00p, 6th floor of bldg. 38.* Supervised lab time. Begin testing simple programs.

- **VIDEO DESIGN REPORT #1 DUE.** Complete in lab.

Monday, January 10.

- **Lab.** *10:000a to 12:00p and 7:00p to 11:00p, 6th floor of bldg. 38.* Supervised lab time. Finish testing simple programs and begin writing programs for your final strategy.

- **Lecture #5.** *3:00p to 5:00p, 34-101* How to program your robot so that it deals well with a dynamic, unpredictable environment. Use the multitasking environment in your software. Learn simple control loops for more sophisticated tasks.

January 11-14.

- **Lab.** *10:00a to 11:00p, 6th floor of bldg. 38.* Supervised lab time. Finish strategies and the construction of your robot.
- **Recitation** To be announced in Lecture Brainstorm strategies; discuss possible obstacles; and robust software programming.

Saturday, January 15.

- **Lab.** *10:00a to 4:00p, 6th floor of bldg. 38.* Supervised lab time. Begin integration of the software, mechanics, and sensors.
- **VIDEO DESIGN REPORT #2 DUE.** Complete in lab.

January 18-21.

- **Lab.** *10:00a to 11:00p, 6th floor of bldg. 38.* Supervised lab time. Finish your robot. Test your robot against other robots on the playing field.
- **Recitation** To be announced in Lecture Debugging hints, and final contest preparations.

Saturday, January 22.

- **Lab.** *10:00a to 4:00p, 6th floor of bldg. 38.* Supervised lab time. Final testing of robot and removing all the bugs. Fine tune your machine. Mock competition at 4:00p.
- **Team Interviews** *10:00a to 3:00p, TBA* Optional interviews to give us feedback on the course, and to express your ideas.
- **Mock Contest** *4:00p, 6th floor of bldg. 38.*
- **VIDEO DESIGN REPORT #3 DUE.** Complete in lab.
- **Lab.** *8:00p to 12:00a, 6th floor of bldg. 38.* Supervised lab time. Fix mistakes you found during the mock competition.

Sunday, January 23.

- **Lab.** *9:30a to 4:00p, 6th floor of bldg. 38.* Supervised lab time. Fix mistakes you found during the mock competition.
- **First Round of the Contest** *6:00p to 8:00p, 34-101*

Monday, January 24.

- **Last-Chance Lab.** *12:01a to 7:00p, 6th floor of bldg. 38.*
- **Robot Impounding.** *7:00p to 8:00p, Chu Lounge (38-201).* **All robots that will compete in the contest must be turned in at this time.**
- **Individual Journal Reports** *10:00p, Chu Lounge* Late reports will not be accepted.
- **Sleep** Get a good night's rest.

Tuesday, January 26.

- **Robot Pickup** *10:00p to 11:00p, Chu Lounge* Pick up your robot from impounding and take it to the contest.
- **The 6.270 Contest, Round 2.** *12:00p to 3:00p, 26-100.* Good luck, everyone!
- **Waiting period.** *3:00p to 6:00p, 26-100* Take a break from it all and get ready for the time of your life.
- **The 6.270 Contest, FINALS** *6:00p to 9:00p, 26-100.* Good luck, everyone!

6.270 1994 Schedule: Week 1

Time	Monday 1/3	Tuesday 1/4	Wednesday 1/5	Thursday 1/6	Friday 1/7
10:00	**Opening Lecture**	**Lab Hours**	**Lab Hours**	**Lab Hours**	**Lab Hours**
	34-101	**6.111 Lab**	**6.111 Lab**	**6.111 Lab**	**6.111 Lab**
11:00	General Information	**38-6th floor**	**38-6th floor**	**38-6th floor**	**38-6th floor**
	Distribute Kits	**(go up in 36)**	**(go up in 36)**	**(go up in 36)**	**(go up in 36)**
12:00	Video Presentation			**Beginners' C**	
				34-101	
13:00					
14:00	**Lab Hours**				
	6.111 Lab				
15:00	**38-6th floor**	**Lecture #2**	**Lecture #3**	**Lecture #4**	
	(go up in 36)	**34-101**	**34-101**	**34-101**	
16:00	Soldering Demos Offered Periodically	Team Organization The Board, Demos Brainstorming	Sensors, Batteries, Motors, and LEGO	Software Welcome to IC	
17:00					
18:00					
19:00	**Lab Hours**	**Lab Hours**	**LEGO Lab**	**Lab Hours**	**Lab Hours**
	6.111 Lab	**6.111 Lab**	Group 1 34-301	**6.111 Lab**	**6.111 Lab**
20:00	**38-6th floor**	**38-6th floor**	**LEGO Lab**	**38-6th floor**	**38-6th floor**
	(go up in 36)	**(go up in 36)**	Group 2 34-302	**(go up in 36)**	**(go up in 36)**
21:00	Soldering Demos Offered Periodically		**Lab Hours**		
			6.111 Lab		
22:00			**38-6th floor**		
			(go up in 36)		
23:00					

6.270 1994 Schedule: Week 2

Time	Monday 1/10	Tuesday 1/11	Wednesday 1/12	Thursday 1/13	Friday 1/14
10:00	**Lab Hours**	**Lab Hours**	**Lab Hours**	**Lab Hours**	**Lab Hours**
	6.111 Lab	**6.111 Lab**	**6.111 Lab**	**6.111 Lab**	**6.111 Lab**
11:00	**38-6th floor**	**38-6th floor**	**38-6th floor**	**38-6th floor**	**38-6th floor**
	(go up in 36)	**(go up in 36)**	**(go up in 36)**	**(go up in 36)**	**(go up in 36)**
12:00		**Recitation #1**	**Recitation #1**	**Recitation #2**	**Recitation #2**
		Group 1 34-301	Group 6 34-301	Group 1 34-301	Group 6 34-301
13:00		**Recitation #1**	**Recitation #1**	**Recitation #2**	**Recitation #2**
		Group 2 34-302	Group 7 34-302	Group 2 34-302	Group 7 34-302
14:00	**Lecture #5**	**Recitation #1**	**Recitation #1**	**Recitation #2**	**Recitation #2**
	34-101	Group 3 34-301	Group 8 34-301	Group 3 34-301	Group 8 34-301
15:00	Integrating Systems	**Recitation #1**	**Recitation #1**	**Recitation #2**	**Recitation #2**
	Control Theory	Group 4 34-302	Group 9 34-302	Group 4 34-302	Group 9 34-302
16:00		**Recitation #1**	**Recitation #1**	**Recitation #2**	**Recitation #2**
		Group 5 34-301	Group 10 34-301	Group 5 34-301	Group 10 34-301
17:00					
18:00					
19:00	**Lab Hours**	**Lab Hours**	**Lab Hours**	**Lab Hours**	**Lab Hours**
	6.111 Lab	**6.111 Lab**	**6.111 Lab**	**6.111 Lab**	**6.111 Lab**
20:00	**38-6th floor**	**38-6th floor**	**38-6th floor**	**38-6th floor**	**38-6th floor**
	(go up in 36)	**(go up in 36)**	**(go up in 36)**	**(go up in 36)**	**(go up in 36)**
21:00					
22:00					
23:00					

6.270 1994 Schedule: Week 3

Time	Monday 1/17	Tuesday 1/18	Wednesday 1/19	Thursday 1/20	Friday 1/21
10:00	Holiday	Lab Hours	Lab Hours	Lab Hours	Lab Hours
		6.111 Lab	6.111 Lab	6.111 Lab	6.111 Lab
11:00		38-6th floor	38-6th floor	38-6th floor	38-6th floor
		(go up in 36)	(go up in 36)	(go up in 36)	(go up in 36)
12:00		Recitation #3	Recitation #3	Recitation #4	Recitation #4
		Group 1 34-301	Group 6 34-301	Group 1 34-301	Group 6 34-301
13:00		Recitation #3	Recitation #3	Recitation #4	Recitation #4
		Group 2 34-302	Group 7 34-302	Group 2 34-302	Group 7 34-302
14:00		Recitation #3	Recitation #3	Recitation #4	Recitation #4
		Group 3 34-301	Group 8 34-301	Group 3 34-301	Group 8 34-301
15:00		Recitation #3	Recitation #3	Recitation #4	Recitation #4
		Group 4 34-302	Group 9 34-302	Group 4 34-302	Group 9 34-302
16:00		Recitation #3	Recitation #3	Recitation #4	Recitation #4
		Group 5 34-301	Group 10 34-301	Group 5 34-301	Group 10 34-301
17:00					
18:00					
19:00		Lab Hours	Lab Hours	Lab Hours	Lab Hours
		6.111 Lab	6.111 Lab	6.111 Lab	6.111 Lab
20:00		38-6th floor	38-6th floor	38-6th floor	38-6th floor
		(go up in 36)	(go up in 36)	(go up in 36)	(go up in 36)
21:00					
22:00					
23:00					

6.270 1994 Schedule: Week 4

Time	XX Sunday 1/23 XX	Monday 1/24	Tuesday 1/25	Wednesday	Thursday
10:00	Lab Hours	Lab Hours			
	6.111 Lab	6.111 Lab	Pick up Robots		
11:00	38-6th floor	38-6th floor	Robot Check-in		
	(go up in 36)	(go up in 36)	26-100		
12:00			Round Two		
			26-100		
13:00					
14:00					
15:00					
16:00					
17:00					
18:00		Impounding	Final Contest		
			26-100		
19:00	Qualifying Round	Get some sleep!			
	All Robots Must				
20:00	Be Here!				
	34-101				
21:00					
22:00					

1.5 Computer Facilities

In this course you will have access to several types of computer facilities. There are two main facilities: the 6th Floor Lab in building 38, and the EECS cluster in room 38-344. Both of these facilities will have playing fields so you can debug your

machine while you edit your code. You can download code to your robots at other athena machines, but you may need a special connector. We recommend that you do most of your debugging at one of the two facilities.

1.5.1 6th Floor Laboratory

This area has some athena machines, which can be used for your purposes. The machines are located near workbenches so you can fix any hardware problems. This is the *only computer location* where you may solder, build, glue, or cut hardware. All hardware work must be done at the benches and not at the athena terminals. The terminals will already have their own cables, and you will not need to remove them.

There will be a few IBM PS2's in the lab for people who will be using the PC as their platform. The number of these machines is limited, so you may need to use the athena machines instead. These may reside on the 5th floor of the EECS labs if there is not enough space.

1.5.2 EECS Cluster

As with all other athena locations, there is to be *NO Soldering, Cutting, or Gluing in the cluster. If anyone is caught doing any of these tasks, not only will you be asked to leave the cluster, but you will also be required to return your 6.270 kit and you will be thrown out of the course. There are no exceptions to the rule.* Debris from cutting wire, soldering, or gluing can get lodged inside the keyboards and short something.

A playing field will be located in the the cluster. This room is to be used only for testing your machines. No soldering or hardware modifications should occur in that room either. All hardware work must be done at home or in the 6th floor lab.

1.5.3 Athena Etiquette

If you use other athena clusters please follow the following rules so that 6.270 is not looked down upon.

- *Noise* Your machines will be quite noisy. If there are lots of people working in the cluster who are trying to get work done, please minimize the machine usage, or move to another cluster.
- *Tidiness* Don't leave your stuff lying around all over the place. Other people have to work and move around.
- *Hardware* Don't solder, glue, or cut any hardware in the clusters. If things go wrong because of this, 6.270 as a whole may suffer, and we may be denied access to athena machines in the future.

- *Locked Screens* Don't leave your screen locked for long periods of time. Towards the end of the month, we will need every available machine. If you lock your screen for more than 20 minutes, we will log you out.

- *Multiple Machines* Don't log on at multiple machines. Also try to minimize the number of people in your team that are logged on. If everyone logs on, then we will need three times as many machines to download to the robots.

If there are any complaints about 6.270 people working in any of the clusters, we will have to make external athena clusters off limits. Violation of the rules will not be tolerated and we will be enforing them strictly.

1.6 Parts List

The parts for this year's contest have been purchased from several different vendors. Some of the vendors are surplus dealers whose stock fluctuates. They are good suppliers of cheap components such as switches, but the availablility from year to year is questionable.

The prices given represent the prices for large quantity discounts. Purchasing the kits in single or small quantities would be much more expensive. The overall cost of the kit would be approximately $500.

Many of the components where the price is not listed have been donated thrrough various companies. LEGO Systems Inc., provided parts to the contest at approximately a %50 to %70 discount off the retail price. Some of these parts wer obtained packaged from the USA division; for these parts, stock numbers are indicated in the parts listing. Other LEGO parts were hand-picked for the 6.270 contest from the LEGO factories in their home country of Denmark.

1.7 Parts List

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1.8 Microprocessor Board

Description	Qty.	Part Numbers	Manufacturer
Capacitors			
0.1uF	6	C4,C6,C7,C8,C10,C12	Active SR205C104KAA
4700pF	1	C3	Active SR151C472KAA
10uF Tantalum	2	C1,C2	Digi-Key P2026
47uF Electrolytic	1	C5	Digi-Key P6213
4.7uF Tantalum	1	C9	Digi-Key P2024
470uF Electrolytic	1	C13	Digi-Key P6230
Resistor Packs			
E47kΩx 9	1	RP1	Digi-Key Q9473
E47kΩx 5	1	RP2	Digi-Key Q5473
V1kΩx 3	1	RP3	Digi-Key Q2102
E1kΩx 5	1	RP4	Digi-Key Q5102
IC Sockets			
16-pin DIP	5	DIP4,DIP8,DIP10 DIP13/14,DIP15/16	Gerber 516-AG11D
14-pin DIP	3	DIP7,DIP9,DIP12	Gerber 514-AG11D
20-pin DIP	2	DIP5,DIP6	Gerber 520-AG11D
28-pin DIP	1	DIP2	Hosfelt 808
52-pin PLCC	1	PLCC1	Methode 213-052-401
Integrated Circuits			
L293B	2	U14, U16	Marshall
L293D	2	U13, U15	Pioneer
DS1233-15	1	U11	Sterling

Note that the parts listed in the box are available from Motorola.

Qty.	Part Number	Description	
1	MC68HC11A1FN	8 Bit Microprocessor PLCC	U1
1	MCM60L256AP12	32K Static RAM	U2
1	MC74HC04	Hex Inverter	U12
1	MC74HC10AN	Triple 3-Input NAND gates	U9
1	MC74HC132AN	Quad Schmitt NAND gates	U7
1	MC74HC138AN	8 to 1 Address Decoder	U4
1	MC74HC244AN	Bus Driver	U6
1	MC74HC273AN	8-bit latch with clear	U5
1	MC74HC373AN	Transparent Latch	U3
1	MC74HC390AN	Dual Divide by 10 Counters	U10
1	MC74HC4053AN	Triple SPDT analog switch	U8
1	TIP120	Power Transistor	Q1

Description	Qty.	Part Numbers	Manufacturer
Miscellaneous parts			
8 MHz Ceramic Resonator	1	XTAL1	Digi-Key PX800
1uH Inductor	1	L1	Digi-Key M7010-ND
50kΩ Trimpot	1	VR1	Digi-Key 36C54
4-AA Battery housing	1	Batt. In.	All BH-4AF
Piezo Beeper	1	Piezo	All PE-18
Heat Sink	2		Digi-Key HS125-ND
LEDs			
Red High-efficiency	6	LED1,LED2,LED3, LED4,LED5,LED6	Active HLMP1700
Green High-efficiency	5	LED7,LED8,LED9 LED10,LED11	Active HLMP1790
Yellow High-efficiency	1	LED12	Active HLMP 1719
1/8 Watt Resistors			
47kΩ	6	R1,R2,R9,R10,R12,R13	Digi-Key 47KE
100kΩ	1	R3	Digi-Key 100KE
10kΩ	1	R4	Digi-Key 10KE
3.3kΩ	1	R5	Digi-Key 3.3KE
2.2kΩ	1	R6	Digi-Key 2.2KE

2.2MegΩ	1	R11	Digi-Key 2.2ME
4.7kΩ	1	R14	Digi-Key 4.7KE
1kΩ	1	R15	Digi-Key 1.0KE
Diodes			
1N4148 glass signal diode	5	D2, D3, D4, D5, D6	Sterling 1N4148
1N4001 Power Diode	1	D1	Motorola 1N4001
Female Socket Headers			
1 x 8 strips	4	Digital input block (3) Expansion Bus	Digi-Key 929974-01-36-ND
1 x 5 strips	3	Port D I/O block (3)	
1 x 4 strips	3	Analog input block (3)	
1 x 12 strips	1	Motor output connector	
1 x 14 strips	1	Expansion Bus	
1 x 7 strips	3	Motor power connector	
1 x 2 strips	1	Expansion power	
Switches			
DPDT slide switch	1	SW1	Digi-Key CKC5100-ND
Red pushbutton	1	SW2	Mouser 10KB-011
Micro-mini pushbutton	2	SW3,SW4	Mouser 101-0010
Jacks			
DC Power Jack	1	J1	Mouser 16PJ031
Modular Phone Jack 6-4	1	J2	Digi-Key H9042

1.9 Expansion Board

Description	Qty.	Part Numbers	Manufacturer
Resistor Packs			
E47k x 9	1	RP5	Digi-Key Q9473
E47K x 7	1	RP6	Digi-Key Q7473
E1k x 7	1	RP7	Digi-Key Q7102
(This is not to be confused with Battery Charger RP7)			
IC Sockets			
16-pin DIP	4	DIP18, DIP19 DIP20, DIP21	Digi-Key ED3316
20-pin DIP	1	DIP17	Gerber 520-AG11D
LEDs			
Red High-efficiency	4	LED13, LED15 LED17, LED18	Active HLMP1700
Green High-efficiency	2	LED14, LED16	Active HLMP1790
Miscellaneous			
50k Trimpot	1	VR2	Digi-Key 36C54
4-position DIP switches	1	SW5	Digi-Key CT1944MST-ND
Heat Sink	1		Digi-Key HS125-ND
1/8 Watt Resistors			
2.2kΩ	2	R16, R17	Digi-Key 2.2KE
Capacitors			
0.1uF Capacitor	4	C16, C17, C18, C19	Active SR205C104KAA
220uF Electrolytic	1	C15	Digi-Key P6228
Male Header Pins			
1 x 2 strip	1	Motor Battery power	Digi-Key 929834-01-36-ND
1 x 5 strip	1	Port D Connector	
1 x 4 strip	1	Analog port connector	
1 x 14 strip	1	Expansion Bus connector	
1 x 8 strip	1	Expansion Bus connector	
Female Socket Headers			
1 x 16 strip	3	Analog input ports	Digi-Key 929974-01-36-ND
1 x 14 strip	1	LCD Connector	
1 x 2 strip	6	Motor connectors, LED Driver connectors	
Integrated Circuits			
L293D	1	U21	

Note that the parts listed in the box are available from Motorola.

Qty.	Part Number	Description	
1	MC74HC374AN	Latch	U17
3	MC74HC4051AN	Analog Mux	U18, U19, U20
2	MPS2222A	T0-92 Package	Q2, Q3

1.10 Battery Charger Board

Description	Qty.	Part Numbers	Manufacturer
Resistor Packs			
V1.2k x 4	1	RP7	Digi-Key 750-83-R1.2K
(This is not to be confused with Exp. Bd. RP7)			
LEDs			
Red high-efficiency	2	LED19, LED20	Active HLMP1700
Green high-efficiency	2	LED21, LED22	Active HLMP1790
Miscellaneous			
DC Power Jacks	2	J3, J4	Mouser 16PJ031
Bridge Rectifier	1	BR1	All KPB02M
Power Resistors			
7.5 Ω, 5 watt	2	R18, R19	Digi-Key 7.5W-5
15 Ω, 2 watt	2	R20, R21	Digi-Key 15W-2
Slide Switches			
Miniature SPDT	2	SW6, SW7	Mouser 10-SP001

1.11 Motor Switchboard

Description	Qty.	Part Numbers	Manufacturer
Diodes			
1N4001	4	D7, D8, D9, D10	Motorola 1N4001
Miscellaneous			
DC Power Jack	1	J5	Mouser 16PJ031
Switches			
2 pole, 3 position	4	SW8, SW9, SW10, SW11	All SSW-11
Female Socket Header			
1 x 3 strip	4	4 motor connectors	Digi-Key 929974-01-36-ND

1.12 Infrared Transmitter

Description	Qty.	Part Numbers	Manufacturer
Resistor Packs			
E47Ωx 5	2	RP8, RP9	Circuit Specialists 26447
LEDs			
Red high-power LEDs	8	LED23-LED29	Digi-Key P363
IR transmitter LEDs	8	LED31-LED38	Motorola MLED71

1.13 Miscellaneous

Description	Qty.	Part Numbers	Manufacturer
LCD Display	1		Timeline 16 x 2 LCD
Modular phone plug 6-4	1		Digi-Key H9092
2.1MM Small I.D. Power Plug	2		All DCSID
12VDC 1 Amp power supply	1		All ACTXX-2000
Nylon screws 6-32 1/4 inch	6		Mouser 561-J632.25
Nylon spacers 6-32 1/2 inch	3		Mouser 561-L6.50
6 feet 4-conductor phone cable			Digi-Key H0043-500-ND

1.14 Actuators

Description	Qty.	Part Numbers	Manufacturer
Futaba Servo	1		Futaba
Solenoid	1		MPJ 3499SL
Mabuchi DC Motors			

1.15 Sensors

Description	Qty.	Part Numbers	Manufacturer
Slotted Break-Beam	4		Motorola MOC70V1
Slotted Break-Beam	2		All OSU-14
Slotted Break-Beam w/ wire	1		All OSU-15
Reflective opto-sensors	2		Digi-Key OR500-ND
Tilt switches	2		All ATS-1
Phototransistors	4		All TIL-99
Long-hinge lever switch	2		Digi-Key SW133-ND
Hinge lever roller switch	2		Digi-Key SW128-ND
Super Mini Switch	5		MPJ 1408SW
Micro Switch	5		MPJ 4173SW
Sharp IR Receivers	4		Sterling GP1U52X
330Ωresistors	10		Digi-Key 330E
High-brightness red LED	4		Electric Goldmine A1012
High-brightness green LED	2		Electric Goldmine A1018
Photoresistors	6		Electric Goldmine G990

1.16 Batteries

Description	Qty.	Part Numbers	Manufacturer
2 Volt 2.5AHr battery	6		Gates D-Cell 0810-0004
1 x 3 D-case top	1		Gates 0201-0125
1 x 3 D-case bottom	1		Gates 0201-0235
AA Batteries	4 per set		

1.17 Building Material

Description	Qty.	Part Numbers	Manufacturer
12 feet red 22-AWG wire			Digi-Key C2101R-1000-ND
12 feet black 22-AWG wire			Digi-Key C2101B-1000-ND
2-sided foam tape 6 inches			
1/4 inch dowel rod - 12 inches			
Heat shrink tubing	1/4 inch		
	1/8 inch		

1.18 LEGO List

Qty/Kit Part No. Description

1	9851	Piston Rod (50) Stop Bush (150) Small Pulley (60) Connector Peg (150) Connector Peg with Stud (10) Connector Peg with Cross axel (10) Pinion (4) Toothed Toggle Joint (4) 1x4 plate with ball (1) 1 stud round (4)
1	9852	Chain Link (175) Broad Chain Link (54)

2	9853	Gears, 8 teeth (50) Gears, 16 teeth (10) Gears, 24 teeth (14) Gears, 40 teeth (8) Crown Wheel (8) Differential Housing (2) Bevel Gears (30)
0.5	9854	Worm gear (10) Gear Rack (12)
0.5	9855	O Ring - tire (12) Pulley Wheel (16) Steering Wheel (4) Spoked Hub (12) Tire - small (8) Tractor Tire (4)
1	9856	Cross Axel, 2 (6) Cross Axel, 3 (6) Cross Axel, threads (4) Cross Axel, 4 (30) Cross Axel, 6 (24) Cross Axel, 8 (14) Cross Axel, 10 (14) Cross Axel, 12 (14) Nut (12)
2	9857	Plates: 1x3 (24), 1x4 (24) 1x6 (16), 1x8 (16) 2x3 (8), 2x4 (20) 2x6 (8), 2x8 (12) Flat 1x8 (4) 1 stud red (4) 1x2 (10), Rotor (6) 2x10 (2), 2x2 (2) 6x8 (2), 4x10 (2) 2x2 Round (4) 1x4 Angle (2)

1	9858	Beams: 1x2 (48), 1x4 (40) 1x6 (8), 1x8 (10) 1x12 (8), 1x16 (12)
1	9862	Universal Joint (8) Piston Head (4) 2x2 Plate Round (8) Angle Plate (8) Swivel Plate (12) Turntable (20) 1x2 Brick Hinge (2)
1	9871	Yellow Beams: 1x2 (14), 1x4 (10) 1x6 (11), 1x8 (14) 1x10 (9), 1x16 (14) 1x2 Inverted Roof (4)
0.333	9869	Building Plate (3)
1	9876	TECHNIC turntable (2)