Introduction to Robotics Syllabus

Day	Time	Goals Students will be able to…	Activities
1.1 Mon	Morning 9 – 11:30 135 min. *(15 min break)*	1. Establish positive social bonds. 2. Understand appropriate behavior for classroom learning 3. Demonstrate to the instructor where their strengths lie and what experience they have with robotics 4. Build investment in course 5. Connect course to real world. 6. Understand step-by-step instruction writing process for programming. 7. 8. Understand some of the basic objects/programming blocks in programming environment	1. **Ice-breakers:** Name games, getting to know you games. 2. **Norms/Rules:** "Course Expectations and Procedures". Review non-negotiable class rules, lab procedures, work and behavioral expectations, material procedures, computer usage. Sign computer use and CTY Honor Code forms. Establish class norms with groups determining top 3 norms, winnow down to **class norm list** on poster. (Groups determined by counting off by 5s.) Teachers observe group dynamics for assigning groups later on. 3. Pretest 4. **KW(L) chart:** activate prior knowledge with videos of robots (internet). K & W of a KWL chart, in poster format. 5. **Journals.** Discuss purpose of keeping a journal (as an engineer and in this course). Create poster. Entry #1: Record your KW for the KWL chart from before. Short share out. 6. **Instruction-writing process:** Fluff/soybutter and jelly activity. Individual students write directions for making a sandwich, swap and critique (or if possible, try them out with real food, following the letter of the instructions, but willfully misinterpreting where directions are flawed). Discussion on elements of **clear instructions.** Class creates poster summarizing key elements (materials, sequenced instructions for every aspect of procedure, description of final result) 7. Get into groups from before. **Inventory NXT kit.** Return extra pieces to extras box, make sure kits are complete. 8. **NXT Programming Workout**: students practice simple programming to get them acquainted with the programming interface and programming, and allow them to actually build something in the first session. Provide an example car and/or instructions for building a car. Groups should complete at least one workout

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			9. **Journal:** reflection on workout. See questions in the footer of this document.
	Afternoon 12:55-2:30 90 min.	9. - 10. Understand to course theme of *interactivity* Understand and recognize what is defined as a robot. 11. – 12. establish journal expectations 13. reinforce *interactivity*	**What are robots? What are they for/what do they do?** 10. **View clips from movies** (E.g., *Star Wars*, *Bicentennial Man*) and real-world footage (Mars rovers, industrial robots, etc.). What are the robots doing? Groups define robots based on observations, share definitions, **arrive at a class definition** (make poster and put up for reference). Instructors make sure concept of *interactivity* is introduced, and models use. *input/output/processor/storage* and *programming* should be introduced as well. 11. **Brainstorm examples of robots** from reality and fiction, add these to the poster. (Add non-examples, too.) 12. **Journal:** Model 3-column notes; students do 3-column notes on IOPS. 13. **Challenge One – Simple Interactive Machine** (*Challenge1.doc*) Students build a machine and write two programs. This may well be pushed into the late afternoon or Tuesday.
	Late Afternoon 3-4:00 60 min.	14. 15. Verbalize and write about what they learned in class today	14. **Continue with Challenge 1.** Groups demonstrate their solutions to Challenge 1 to each other. Discussion of strategies, challenges, and solutions. 15. **Journal:** see questions in the footer of this document.
1.2 Tues	Morning 9 – 11:30 135 min. *(15 min break)*	1. Make simple robots utilizing the motor, stop, wait for, touch sensor, and light sensor icons	1. **Morning meeting:** continue icebreakers that were popular yesterday. Review yesterday's robotics work (IOPS, interactivity) 2. **Present today's challenge** (*Challenge2.doc*), but don't start it yet. 3. **Review** (as needed): **palette arrangement** (students should be using palette sheet as source for vocab when using journals). **Wiring/Linking** (match the data types for input and output blocks). **Commenting** – o Commenting in your algorithm broken into segments first and then coding the pieces underneath.

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			o Comments that identify programmer name, date, edits and other program metadata. 4. **Tricks and shortcuts** - have the students start a tricks and shortcut page in the notebooks (possibly the inside cover/end). Students can share periodically. 5. **Mysterbot:** simple loop. Show students a mysterbot car that performs a very simple loop. In journals, have them describe in English what they think the program is, then recreate the program. (The loop could be as simple as "go forward 5 rotations, stop, beep, repeat".) 6. **Prep for Lab #2 with** *Help_Quest1.doc*. Discuss the answers with emphasis on the concepts of modifiers, loops, and conditionals. *7.* **Lab #2 – NXT Programming Workout Two** (*NXT_Workout1.doc* – yes #1, from the Tuesday week 1 folder)– conditionals, loops. As appropriate, do first workout together. Have the students build a different robot vehicle from the day before. This lab will probably flow into the afternoon.
	Afternoon 12:55-2:30 90 min.	2.	8. **Looping challenge:** *Challenge2.doc*. Follow directions on the challenge sheet
	Late Afternoon 3-4:00 60 min.	3. Verbalize and write about struggles they had with their robots today	9. **Continue looping challenge** 10. **Journal:** see questions in the footer of this document.
1.3 Wed Revision (actual)	Morning 9 – 11:30 135 min. *(15 min break)*	1.	1. **9-10am. Finish Challenge1**. Emphasize they are evaluated on making progress. Instructor/TA continue informal conferences periodically, making sure groups note problems and solutions in journals. **Groups present to each other. Photograph/video presentations and robots, dismantle.** 2. **Mysterbot:** simple loop. Show students a mysterbot car that performs a very simple loop. In journals, have them describe in English what they think the program is, then recreate the program. (The loop could be as simple as "go forward 5 rotations, stop, beep, repeat".) (In 2009, use

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			C&D's object-avoiding car. This loops "if ultrasonic sensor detects nothing, go forward; elseif ultrasonic sensor detects something within 10cm, turn right 1 degree".) 3. **Prep for Lab #2 with** *Help_Quest1.doc*. Discuss the answers with emphasis on the concepts of modifiers, loops, and conditionals. 4. **Lab #2 – NXT Programming Workout Two** (*NXT_Workout1.doc* – yes #1, from the Tuesday week 1 folder)– conditionals, loops. As appropriate, do first workout together. Have the students build a different robot vehicle from the day before. This lab will probably flow into the afternoon.
1.3 Wed	Morning 9 – 11:30 135 min. *(15 min break)*	2. Understand the importance of structure, center of gravity, and good design in robot building 3. Build a sturdy robot frame	5. Discuss the importance of structure, center of gravity, and good design in robot building 6. Robot design activity
	Afternoon 12:55-2:30 90 min.	4. Use and understand gears to apply 5. Build a robot to perform a useful task 6. Get comfortable using Robolab and building robots	7. Discuss gears 8. Sophisticated Interactive Machine robot challenge. (see course binder)
	Late Afternoon 3-4:00 60 min.		9. Continue interactive machine challenge. Present to class, journal.
1.4 Thurs	Morning 9 – 11:30 135 min. *(15 min break)*	1. Recognize the important aspects of robotics – trial and error, testing, observation, theorizing, programming, building, etc.	1. Students already have knowledge of simple forever loops and forks. 2. Workout: Walk the Dog. Name file "Walk the Dog___.rbt" (insert group members' initials at end). Your dog should follow its own in a straight line. Comment your program and journal 3. Workout: Walk the Slightly Smarter Dog. "Walk the SSD___rbt". Your dog is nearsighted and can only see 1m ahead. The owner stops to talk to

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			neighbors and speeds up when crossing streets. Your dog shouldn't lose sight of its owner, and should obediently wait when the owner stops. Comment program and journal. 4. Workout: Walk the Even Smarter Dog. "Walk the ESD___rbt". Your dog should be able to follow you even when you change direction slightly. Can you get your dog to figure out which direction you went in without spinning around completely?. Comment, journal. 5. Workout: Chase a Dog. Your dog loves to wrestle! When it sees a puppy pal it should chase it and catch up. Comment, journal. 6. Debrief program designs. 7. Break. 8. Finish up journaling and commenting on the workouts each group completed (it's okay if not all groups finish all the workouts). 9.
	Afternoon 12:55-2:30 90 min.	2. Verbalize their understanding of robotics 3. See a different perspective on programming by seeing others' presentations	10. **Variables intro:** Mystery Program: show students "mysteryprogramv.rbt", which shows variables and a display block. They should try to determine what it does, first by looking at the program, then by looking at copies on their own computers and using the help in the Mindstorms program. Students will view a tutorial (www.ortop.org/NXT_Tutorial/variables.html) which is listed as a comment in the "mysteryprogramv.rbt" file. 11. **Variables minilesson:** as needed, teach about declaring variables, variable types (number, text, logic). This is all covered in the ortop.org tutorial. 12. **Variables: HelpQuest3ase.doc**
	Late Afternoon 3-4:00 60 min.	4. Make simple robots utilizing the jump, loop, split task, and fork icons 5. Verbalize and write about what worked and didn't work	13. **Variables: finish HelpQuest3ase.doc.** In 2009 this proved to be very time-consuming; we were able to construct a program to count while the light sensor was looking at a black line, but it wouldn't count just once for each line.

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		within their partners (group-working skills)	
1.5 Fri	Morning 9 – 11:30 135 min. *(15 min break)*	1.	1. Introduce BattleBot challenge as an opportunity to utilize skills learned to date. Emphasize connection to the Walk the Dog exercises – you should be able to locate and destroy your opponent! 2. Divide building and programming tasks among group members. Build prototypes.
	Afternoon 12:55-2:30 90 min.	2. Recognize the importance of attention to detail in robotics 3. Improve troubleshooting and debugging skills	3. Fine-tune designs. Test matches. Peer feedback across groups. 4. Journal.
	Sunday eve. 6:30 – 8pm 90 min.	4.	5. Finalize BattlBots.
2.1 Mon	Morning 9 – 11:30 135 min. *(15 min break)*	1. Verbalize and write about approach to robot design and programming using appropriate vocabulary	1. BattleBot competition with IROB-A. 2. Get back journals with instructor's feedback, gallery walk of good examples, reminder of final conference (so do a good job documenting) 3. Read article on swarm theory from Science News (By Susan Milius May 9th, 2009; Vol.175 #10 (p. 16) "SWARM SAVVY How bees, ants and other animals avoid dumb collective decisions" - decentralized systems in nature). Connect to the following challenge: 4. **Foraging Challenge:** Lay out challenge of getting a robot "scout" ant to find food (green tape), go back to the colony, and get another ant ("food-gatherer" or by popular consensus in 2009, the "minion") to come get food. Groups break down this complex task into constituent parts, present to each other, add to their list of subtasks. Table this – it will require NXT-NXT communication, may require parallel program functions, and logic variables. 5. Students use help function to find out how to set up NXT-NXT

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			communication to get one robot to disply a number given by another robot. NOTE: in 2009 we had a lot of trouble getting each of the 6 NXT blocks to connect with each other. Several parings worked, while others didn't 6. Students block out the structure of the Foraging Challenge programs (one for the scout, the other for the minion).
	Afternoon 12:55-2:30 90 min.	2. Make a robot that uses variables to count the number of lines it passes	7. Line count robot challenge. Take ideas and record on board. Groups try their ideas. Do *not* give away any solutions. 8. Debrief on problems. Give hint of using "wait for light" block. Repeat previous step.
	Late Afternoon 3-4:00 60 min.		9. Finish line count challenge 10. Journal. 11. Note: in 2009 students needed more time but were fatiguing, so the conclusion of this challenge was postponed.
2.2 Tues	Morning 9 – 11:30 135 min. *(15 min break)*	1. Simulate a centralized system.	**Continue Foraging Challenge**: (see files "forage - scout.rbt" and "forage - minion.rbt" for possible programming solutions) 1. Groups share basic structure of their programs with other groups. Teacher-led debrief. 2. Mini lesson on making a **line-following program with a single light sensor.** Groups build, test this subroutine.
	Afternoon 12:55-2:30 90 min.	1. Learn about subroutines	3. Mini lesson on subroutines and their equivalent in the NXT envinronment (**MyBlocks**). Groups make Myblocks for the line-follower. 4. Mini lesson on controlling the line-following subroutine with a logic-controlled loop.
	Late Afternoon 3-4:00 60 min.		5. Finish Foraging Challenge, test each group's robots and compare results. What made groups successful? Journal with a focus on how to improve designs. **Note:** in 2009 we had a lot of problems getting reliable connections between the NXT blocks and had to postpone the conclusion of this challenge until this could be resolved.
2.3	Morning		6. Complete line count challenge and demonstrate.

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Wed	9 – 11:30 135 min. *(15 min break)*		
	Afternoon 12:55-2:30 90 min.	2. Prepare for Ping Pong Capture Competition. 3. Build an immobile robot that serves a purpose	Introduce a series of challenges to work on for the rest of the week. These challenges are progressively more difficult; as long as students have made reasonable progress on them, they will be prepared for the **Ping-Pong Capture Competition** at the end of the week. Progressing further in this list of challenges will allow them to make more effective entries in the competition. Debrief and journal as in previous lessons. 7. **Ball Capturer Challenge:** build the tribot with touch-sensor-activated pincers. It should be able to run into a 2-inch diameter ball and grasp it. 8. **Picky Ball Capturer Challenge:** same as above, but uses light sensor to decide whether to keep balls (keep blue, discard red) 9. **Hoarder Challenge:** same as above, but brings the ball back to its 'lair'. 10. **Ball Sorter:** construct a stationary conveyor belt robot that sorts balls according to color. May use white and black ping pong balls or the blue and red balls that come with the NXT kits. 11. **Greedy Bot Challenge**: similar to Hoarder, but uses ultrasonic sensor to identify groups of ping pong balls, and is able to capture several at a time to bring back to its lair. This is the ideal entrant for Friday's contest.
	Late Afternoon 3-4:00 60 min.		12. Continue above challenges in preparation for **Ping-Pong Capture Competition**
2.3 Wed	Morning 9 – 11:30 135 min. *(15 min break)*		1. Continue above challenges in preparation for **Ping-Pong Capture Competition**

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	Afternoon 12:55-2:30 90 min.	1.	2. Continue above challenges in preparation for **Ping-Pong Capture Competition**
	Late Afternoon 3-4:00 60 min.	2.	3. Continue above challenges in preparation for **Ping-Pong Capture Competition**
2.4 Thurs	Morning 9 – 11:30 135 min. *(15 min break)*	1.	1. Continue above challenges in preparation for **Ping-Pong Capture Competition**
	Afternoon 12:55-2:30 90 min.		2. Continue above challenges in preparation for **Ping-Pong Capture Competition**
	Late Afternoon 3-4:00 60 min.		3. Continue above challenges in preparation for **Ping-Pong Capture Competition**
2.5 Fri	Morning 9 – 11:30 135 min. *(15 min break)*		1. Continue above challenges in preparation for **Ping-Pong Capture Competition** 2. Set up arena for **Ping-Pong Capture Competition**
	Afternoon 12:55-2:30 90 min.	1.	3. **Ping-Pong Capture Competition**

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	Sunday eve. 6:30 – 8pm 90 min.		4. Review the week ahead. Journal on Ping-Pong Capture Competition
3.1 Mon	Morning 9 – 11:30 135 min. *(15 min break)*	1.	1. Start class with introduction to final projects (Mega_Projects.doc), showing a slideshow with each project option on a slide. Take questions, write original options thought of by students on board. 2. Review Week 2 Post Test: whole group review of test items after students have 5 minutes to review their tests. Tell students topics for each test item. Run re-teaching mini lessons on each topic for selected students. Give alternate mini-assessments and have students write in journals about what they learned about the topic. 3. Students who are not working on relearning items from the test start on their final projects. A project proposal written in the journal is required before any building or programming can take place.
	Afternoon 12:55-2:30 90 min.	2. Use robotics skills to do reverse engineering	4. Continue final project.
	Late Afternoon 3-4:00 60 min.	3. Begin to understand the inside workings of a robot 4. Complete a circuit and create AND and OR gates	5. Test final projects and present preliminary results to peers. 6. Journal.
3.2 Tues	Morning 9 – 11:30 135 min. *(15 min break)*	1.	1. Revise final projects, each group doing a final demonstration to the rest of the class. Videotape and photograph for conferences on Friday.
	Afternoon 12:55-2:30 90 min.	2. Calculate torque 3. Build a robot with the consideration of torque 4. Build a robot that will do off-	2. Discussion on torque 3. All-terrain robot challenge

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		road racing	
	Late Afternoon 3-4:00 60 min.		4. Continue Scout-Minion Foraging Challenge from last week, now that NXT blocks have been successfully connected via BlueTooth
3.3 Wed	Morning 9 – 11:30 135 min. *(15 min break)*		1. Review Pre-Tests and revise in a different colored pen in order to prepare for tomorrow's Post-Test. 2. Continue Scout-Minion Foraging Challenge from last week.
	Afternoon 12:55-2:30 90 min.		3. Finish Scout-Minion Foraging Challenge.
	Late Afternoon 3-4:00 60 min.		4. Scout-Minion competition (whole class), Groups present challenges and solutions to other groups. 5. Journal.
3.4 Thurs	Morning 9 – 11:30 135 min. *(15 min break)*	1. Evaluate their instructor and TA 2. Clean up and organize for next years class	1. Instructor/Course/TA evaluations 2. Final exam review 3. Final exam (post test)
	Afternoon 12:55-2:30 90 min.		4. Each student prepares final conference PowerPoint presentation on their successes and struggles throughout the course (to future instructors: requires frequent video and picture documentation)
	Late Afternoon 3-4:00 60 min.	3. See what the future has in store for robotics 4. Perhaps be inspired to further their robotics studies	5. Review final exam results and compare to pre-test.
3.5 Fri	Morning 9 – 11:30 135 min.	1.	1. Organize Lego kits 2. Collect all program files and picture/video documentation and burn onto a CD to take home.

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	(15 min break)		3. Finish KWL chart. 4. Research robots in the real world online and do brief presentations to class.
	Afternoon	2.	5. Conferences. Students give presentations to parents during conferences.

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