Spectrum Program
Session 1
Course Title: Robotics Honors

Course Description
Did you know that iPods, microwaves, copy machines, cell phones, and universal remote controls are all robotic systems? This hands-on course focuses on mechanical construction, characteristics of sensors, motors, and batteries, and control strategies for autonomous robots. Students are members of class teams that design, build, and program complete robots that compete in competitions. Biologically-inspired approaches to the design and control of autonomous robots are emphasized. This course is a precursor for future study in science, engineering, and/or biomedicine.

Additional emphasis will be placed on understanding how our designs for robotic systems have changed over time, why some kinds of tasks are more difficult than others for robots, and which robotic abilities remain in the realm of science fiction at the present time.

Essential Questions
• How have our designs of robotic systems changed over time?
• Why are some kinds of tasks difficult for robots?
• How can we solve design problems when we do not have a step-by-step recipe to follow?

Outcomes
Upon successful completion of this course, students should:
- know the functions of fundamental components of robotic systems
- know the functions of fundamental computer programming elements
- understand the history and development of robotics, identifying trends and milestones
- understand the differences in the difficulties of different tasks for robotic systems
- understand the differences in the complexity of programming required for different robotic tasks
- understand the limitations of robotic systems, distinguishing between science fiction and reality
- be able to create simple robots that move through and sense their surroundings
- be able to analyze and distinguish among tasks posing different levels of difficulty for robots
- be able to analyze and plan (flowchart) simple computer programs (instructions) to control robots
- be able to analyze, diagnose, & troubleshoot ("de-bug") simple computer programs
- be able to collaboratively analyze and solve robotic system design problems using the Engineering Problem-Solving Cycle

Instructional Strategies
Instruction will be differentiated to support students with varying degrees of prior experience with LEGO Mindstorms Robotics and /or LOGO computer programming. Students new to robotics may begin by completing self-paced introductory projects using NXT kits while students with previous NXT experience may have the opportunity to begin using Tetrix kits to pursue more challenging projects without delay.

Students will have options for choosing the robotic design project challenges that they pursue, including the ability to propose their own projects. At the same time, students will also have the opportunity to choose to collaborate with other students as a design team to pursue a given design challenge.

The majority of class time will be devoted to student project work, during which a variety of differing projects may be pursued by different groups of students at the same time.

Resources and Materials

- **Books**
  a. Mataric, Maja, The Robotics Primer, Cambridge, MIT Press, 2007; ISBN-10: 0-262-63354-X ISBN-13: 978-0-262-63354-3
- **Web sites**
  a. TBA
- **Other Media**
  a. Student Guides supplied with kits & available electronically / online
- **Materials**
  a. Mindstorms NXT Kit, Tetrix Kit, Notebook / Journal, Laptop computer; USB drive

Student Assessment

- **Pre-Assessment**
  Pre-Assessment: Students' prior general knowledge about robotics, and previous experience building and programming robots will be diagnosed. Knowledge of key concepts and vocabulary will be quantified using an instructor-generated, constructed-response instrument based on the course text.

- **CTD Grading Scale**

A+	100-97%	A	96-93%	A-	92-90%
B+	89-87%	B	86-83%	B-	82-80%
C+	79-77%	C	76-73%	C-	72-70%
D+	69-67%	D	66-63%	D-	62-60%
F	below 60%				

- **Breakdown of Final Grade**
  20% Out-of-class research projects: Timeline for History of Robotics; List of Fictional Robot Abilities
  20% Performance Assessments: Using fundamental construction and programming elements; Creating a Flowchart; "De-bugging" / Trouble-shooting a program; Using the Engineering Problem-Solving Cycle; Rating / Ranking difficulty of robotic tasks; Identifying trends in robotics
  25% Notebook / Journal: Robot Design & Testing Notes; Notes From Reading
  25% Robot Design Projects: construction & programming of robots for challenges
  10% Final Exam (Post-assessment)

- **Post-Assessment**
  Students' general knowledge about robotics, and specific knowledge about building and programming robots will be assessed. In addition to a quantitative assessment of concepts and vocabulary, evidence may include a "portfolio" / exposition of video clips of robots that students have designed, constructed, and programmed during the course.

Schedule

Date(s)	Topic(s)	In-class Activities	Assignments / Assessments
Day 1 (Monday) June 27	Pre-assessment; Intro to robotic systems, & components; • Components • Programming Elements	Whole-class discussions; Individualized assistance Student project work: • introductory tutorials & reading • brainstorming / robot proposals	Notebook: • notes on components & construction • notes from project work
Day 2 (Tuesday) June 28	Intro to robotic systems, & components (cont) • Components • Programming Elements	Whole-class discussions; Individualized assistance Student project work: • introductory tutorials & reading (cont) • brainstorming / robot proposals (cont)	Notebook: • notes on components & construction • notes, Ch's 1, 2 & 3 • notes from project work
Day 3 (Wednesday) June 29	Movement Options: Arms, legs, wheels, tracks…biological inspiration Planning program instructions: • Flowcharting • Psuedocode	Whole-class discussions; Individualized assistance Student project work: • movement challenges • sensing challenges	Notebook: • notes on flowcharting & programming • notes, Ch's 4, 5 & 6 • notes from project work
Day 4 (Thursday) June 30	Sensing Options: Touch, distance, sound, light…biological inspiration Diagnosing Problems / De-Bugging: • Inserting "flags" / markers for tracing • Stepping-through line-by-line	Whole-class discussions; Individualized assistance Student project work: • movement challenges • sensing challenges	Notebook: • notes on debugging / trouble-shooting • notes, Ch's 7, 8 & 9 • notes from project work • notes on research for Timeline Performance: Using fundamental construction and programming elements
Day 5 (Friday) July 1	• What tasks are difficult for real-world robots? • How have robot designs changed over time? • How have robot components changed over time? • How have robot abilities changed over time?	Whole-class discussions; Individualized assistance Student project work: • movement challenges • sensing challenges	Research Project: Timeline for History of Robotics Notebook: • notes on difficulty of tasks & trends over time • notes from project work Wrap-up 1st Wk Projects
Day 6 (Monday) July 4	Engineering Problem-Solving Cycle:	Whole-class discussions; Individualized assistance	Performance: Creating a Flowchart

	• re-defining the problem • brainstorming alternatives • choosing criteria to rate alternatives • testing alternatives	Student project work: • movement challenges • sensing challenges	Notebook: • notes on Problem-Solving Cycle • notes from project work
Day 7 (Tuesday) July 5	• How complex does a robot's "thinking" need to be in order to complete different tasks? • How much information does a robot need to complete different tasks? • How can a robot interact with its environment to obtain the information that it needs?	Whole-class discussions; Individualized assistance Student project work: • movement challenges • sensing challenges • thinking challenges	Performance: Debugging / Trouble-shooting Notebook: • notes on "thinking" demands / strategies • notes, Ch's 10, 11 & 12 • notes from project work
Day 8 (Wednesday) July 6	Thinking Options 1 & 2 …biological inspiration • Deliberative Control • Reactive Control	Whole-class discussions; Individualized assistance Student project work: • movement challenges • sensing challenges • thinking challenges	Performance: Using Engineering Problem Solving Cycle Notebook: • notes on thinking options • notes, Ch's 13 & 14 • notes from project work
Day 9 (Thursday) July 7	Thinking Options 3 & 4 …biological inspiration • Hybrid Control • Behavior-based control	Whole-class discussions; Individualized assistance Student project work: • movement challenges • sensing challenges • thinking challenges	Performance: Rating / Ranking Tasks by Difficulty Notebook: • notes on thinking options • notes, Ch's 15 & 16 • notes from project work
Day 10 (Friday) July 8	What futuristic abilities are portrayed in science fiction robots? Based on historical trends for robotic design, what abilities are likely to become possible within the near future or the more distant future?	Whole-class discussions; Individualized assistance Student project work: • movement challenges • sensing challenges • thinking challenges	Research Project: Fictional Robot Abilities Notebook: • notes on futuristic abilities • notes from project work Wrap-up 2nd Wk Projects

Day 11 (Monday) July 11	Consultations -- construction & programming • Re-defining the problem • Brainstorming alternatives • Criteria for Choosing among Alternatives	Student project work: • movement challenges • sensing challenges • thinking challenges • team competitions	Notebook: • notes, Ch's 17 & 18 • notes from project work
Day 12 (Tuesday) July 12	Consultations construction & programming: • Testing alternatives • Re-defining the problem	Student project work: • movement challenges • sensing challenges • thinking challenges • team competitions	Notebook: • notes, Ch's 19 & 20 • notes from project work
Day 13 (Wednesday) July 13	Consultations: • Problem-solving cycle • de-bugging / troubleshooting	Student project work: • movement challenges • sensing challenges • thinking challenges • team competitions	Notebook: • notes, Ch's 21 & 22 • notes from project work
Day 14 (Thursday) July 14	Consultations: • Problem-solving cycle • de-bugging / troubleshooting	Student project work: • movement challenges • sensing challenges • thinking challenges • team competitions	Wrap-up 3rd Wk Projects
Day 15 (Friday) July 15	Post-Assessment	Student project work: • movement challenges • sensing challenges • thinking challenges • team competitions	Post-Assessment / Final Exam

CTD Statement on Third-Party Web Sites

Instructors are required to thoroughly review any third-party web sites they intend to use in their courses for inappropriate content. However, because web content continuously changes, CTD disclaims any responsibility for any of the content contained on third-party web sites used in course materials. If you become aware of anything that may be inappropriate, please notify CTD staff immediately.