Haptics is to touch, as optics is to sight.

Instructors: Prof. William Provancher, MEB 2136, 581-4119, wil@mech.utah.edu (I greatly prefer you contact me during office hours or by email)

Office Hours: T 1:30-2pm, Th 2-2:30pm and by appointment (please email in advance)

Units: 3

Meeting Sessions: Tuesday and Thursday, 10:45am-12:05am, Room MEB 3147

Lab: MEB 2172 (Small Robotics Lab)

Reference Texts:
• Human Haptic Perception Basics and Applications. Grunwald, Martin (Ed.) 2008
• Haptic Rendering: Foundations, Algorithms, and Applications by Ming Lin (Editor), Miguel Otaduy (Editor) 2008.

Course Website: http://mech.utah.edu/haptics

Prerequisites: Robotics (ME5220/6220), Advanced Controls (ME5200/6200), C++ programming

Course TA: Andrew Doxon, adoxon@gmail.com (best reached by email)

Course Summary
This course will give students a broad overview of the topic haptics, which is the study of touch: touch sensing, perception, cognition, and feedback. The course is organized into two halves where the first half of the course aims to rapidly bring students up to speed with the basics of haptics through lectures, homework/labs, readings on classical and current topics in haptics. Through homework lab exercises, students will learn to program basic feedback behaviors with a haptic device. The focus of the second half will be a term project; however, students will continue to meet during class to discuss readings (and perhaps for additional lectures). Through readings and conducting their own projects, students will learn to think critically about prior work presented in the haptics literature as well as their own work and begin to abstract ideas from prior work to form their own research hypotheses. See the course website for more details. (Note that “first half” of the course really means the first ~9 weeks of the course, before spring break)

Course Objectives (Course learning outcomes)
1. Provide a broad overview of haptics through readings and lectures
2. Provide students with a hands-on opportunity to program a haptic device
3. Read and discuss important papers relevant to current haptics research
   a. Begin to think critically about the haptics literature
   b. Begin to abstract ideas from prior work and other fields to formulate new research
4. Provide hands-on experience with haptics research through a term-based research project.
   a. Propose and present a project to the class and peers
Acknowledgement
We would like to acknowledge the many colleagues whose course materials were borrowed and adapted in putting together this course, namely: Drs. Allison Okamura (JHU), Katherine Kuchenbecker (UPenn), Francois Conti, Federico Barbagli, and Kenneth Salisbury (Stanford), Ed Colgate (Northwestern), Hong Tan (Purdue), Blake Hannaford and G. Sankaranarayanan (U. Washington), and Karon MacLean (UBC).

Course Schedule & Topics
The following topics are intended to be covered. Reading assignments will be made in each lecture that should be read before the next lecture. Course topics will likely include: an overview of human haptic sensing, neurophysiology and psychophysics, physical haptic systems, haptic device design, haptic rendering, an overview of experiment design and statistics, fundamentals of teleoperation, control, and stability. Other topics may also include: issues in device design for humans, improvements in haptics, and modeling humans (limbs and system ID).

Homework/Labs
There will be roughly 7-10 homework assignments. Homework assignments will be completed individually unless otherwise noted, and will involve applying knowledge gained from lectures and readings. Some of the homework assignments will be lab exercises performed with haptic devices that are available in the “Small Robotics Lab” in MEB 2172. These exercises will be completed in 2-person teams and will primarily involve programming a haptic device, such as a Falcon or Haptic Paddle using C/C++ and Microsoft Visual Studio 2008. Other

The course TA will establish a time for at least one of his office hours to be held in the Robotics lab, to facilitate answering lab related questions. Otherwise, students will complete labs independently on their own schedule with 24 hour access provided to the robotics lab by your student ID and card reader (please email Dr. Provancher your full name, UID # in the form “Firstname Lastname”, “u0xxxxxx”, and card# in the form “xxxx xxxx xxxx xxxx”).

Class participation
Students will be expected to read articles that are assigned in a given lecture in time for the next lecture and then be prepared to participate in discussions or state what kind of questions they have. This will facilitate the coverage of lecture material in the first half of the course. 1-2 articles will often be assigned to read for each class meeting (assigned in the prior lecture) for the first half to two-thirds of the course.

Paper Presentation
Class meetings in the last third of the course will be used primarily to have each student present on one paper (in detail) or on a number of papers (in less detail) that is/are related to that student’s course project. Each student will prepare a ~10 minute PowerPoint presentation to present the main points of the paper, including important details such as experiment design, results and discussion points. The student will also make it clear to the class why this paper is relevant and related to their course project. The student will then take questions and the hope is that the class will have some feedback to provide relative to this research topic. A different paper will be presented by each student.

The papers that are presented will be posted on the course website after each student chooses the paper they will present. Everyone in class is expected to at least skim the papers that are presented prior to it being presented in class. A schedule for presentations will be established after project topics are chosen.

Course Project
The term project constitutes a major portion of each student’s grade. Students should work with the instructor to choose an appropriate haptic related project of interest, which could be related to the student’s research. The project will require significant planning, starting in the 2nd or 3rd week of class
and will be the students’ primary focus in the second half of class. The course project could be worked on individually, but is recommended to be worked on in teams of 2 or 3. Your team mates may be the same as who you worked with for the lab-based homework assignments. Part of the project grade will be derived from written assignments (e.g., project proposal) and oral presentations made by students en route to formalizing their project scope. A third of the final project grade is derived from the project final report, which may be in the form of a web-based or Word document. Further details concerning projects will be discussed in class and be posted on the course website.

### Grading

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<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Course</td>
<td>35%</td>
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<tr>
<td>Homework/Labs</td>
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<tr>
<td>Class Participation</td>
<td>10%</td>
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<tr>
<td>(Readings and in-class</td>
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<td>comments/discussions)</td>
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<tr>
<td>Individual Paper Presentation</td>
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<td>(Paper chosen related to</td>
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<td>project)</td>
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<td>Project</td>
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<td>(33% of this for the final</td>
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<td>report)</td>
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<tr>
<td>Project Presentation</td>
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This class will be graded on a straight scale where 95 = A, 90 = A-, 88 = B+, 85 = B... However, if scores are lower than expected (i.e., below a B or B+ average), grades may be curved up.

### Late Policy

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<td>1 day</td>
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<td>2 days</td>
<td>70%</td>
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<td>3 days</td>
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<td>&gt;4 days</td>
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### Classroom conduct

Use of cellular phones and text messaging is strictly prohibited in class. Laptops may only be used to take notes. If you are playing games, browsing the web, emailing, etc., you will be asked to stop or to leave the classroom. This is not respectful towards your classmates or instructor. Please also keep classroom conversation focused on class topics.

### Policy on collaboration (cheating)

Students are invited to discuss how to complete assignments; however, must complete work independently (labs may be done in pairs). If you turn in the same work as someone else, all parties will receive a zero for the assignment and will likely result in a note being placed in your academic folder. We will also conduct plagiarism checks by comparing what you turn in to assignments from previous offerings of the course and other published solutions. A 2nd offense will mean a visit to the ME Dept. Academic Advisor and possible suspension.

### Americans with Disabilities Act of 1990

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability Services.