A number of haptics researchers offer courses devoted to haptics or have haptics as a major component of a course. The increasing number of these offerings is perhaps best exemplified by the tutorial held at the 2012 Haptics Symposium in Vancouver that was devoted to “Best Practices for Teaching Haptics” (http://2012.hapticssymposium.org/node/68.html). In this issue of “News from the Field,” we feature some of these courses that cover a variety of content, haptic development platforms, and target different audiences. If available, a link to the course has been given. I would like to thank the instructors of these courses for providing the material for this feature.

Course: Introduction to Haptics (http://hapticsonline.class.stanford.edu)
Allison Okamura
A. Okamura is with the Department of Mechanical Engineering, Stanford University.

This is a self-paced, modular, on-line course in which participants learn how to build, program, and control haptic devices. In the course, participants gain an appreciation for the capabilities and limitations of human touch, develop intuitive connections between equations that describe physical interactions and how they feel, and gain practical interdisciplinary engineering skills related to robotics, mechanical engineering, electrical engineering, bioengineering, and computer science. Laboratory assignments involve the Hapkit (http://hapkit.stanford.edu), which is a low-cost, easy-to-assemble haptic device that allows users to input motions and feel programmed forces in one degree of freedom. Using the Hapkit, participants gain hands-on experience in assembling mechanical systems, making circuits, programming Arduino-based micro-controllers, and testing their haptic creations. The figure illustrates the Hapkit being used by Tania Morimoto, a Stanford Mechanical Engineering graduate student, who was the primary developer of Hapkit (photo by Jonathan Edelman).

Course: Advanced Haptics
Seungmoon Choi
S. Choi is with the Department of Computer Science and Engineering, Pohang University of Science and Technology (POSTECH), Korea.

This course for graduate students pertains to tactile perception and rendering. Half of the course covers the practical implementation of psychophysical techniques used to study haptic perception and how metrics derived from these methods, such as perceptual thresholds and perceived magnitude functions, can be used to understand haptic perception. Students can become more familiar with these methods by completing an interactive series of on-line psychophysical experiments. The second part of the course focuses more on technology, in particular on tactile actuators and systems, tactile rendering algorithms, and methods for controlling single- and multiple-actuators. The course concludes with an introduction to various cutting-edge applications of tactile rendering. As part of the course, students are required to complete a project in which they design and build a tactile system which is then evaluated experimentally using human subjects. The figure shows a haptic neckband developed as part of the course project which provided vibrotactile feedback when a user is detected to be in forward head posture (from Lee et al. “PreventFHP: Detection and Warning System for Forward Head Posture.” Proceedings of the IEEE Haptics Symposium, pp. 295-298, 2014)
Course: Physical User Interface Design

Karon MacLean

This is a graduate-level introduction to the inception, creation, and evaluation of physical and multimodal human-computer interfaces. It emphasizes the control and/or display of virtual environments through the sense of touch for the purpose of human-system communication, as well as perceptual/attentional foundations. Types of communication studied include tactile signaling, affective touch, and shared control between humans and smart systems. The course is based on interactive design with haptic force-feedback and tactile display technology used as the means, either alone or in combination with other sensory modalities, for solving real problems. In the course, haptic force-feedback and tactile display technology is used as the means, either alone or in combination with other sensory modalities, and the focus is on interaction design that is necessary for solving real problems. The course covers topics such as the basic principles of haptic interfaces, their actuation, control and programming, haptic rendering of rigid and deformable surfaces, human haptic perception and psychophysical methods used to study this, and application areas of tactile and haptic displays. The course’s labs and projects use Arduino-based “haptic sketching” and involve a rapid iterative cycle in design explorations. The project for the course involves taking a physical interface concept through multiple iterative cycles of design and description and finally fabrication of a testable interface. The figure shows students conducting an informal communication experiment during the course with a haptic sketch.

Course: Sensorimotor Behavior, Motor Learning, and Haptic Function

Vincent Hayward and Etienne Burdet

The goal of the course is to introduce students to models and empirical findings regarding sensorimotor behavior in humans and associated learning and its contributions to purposeful and discriminative touch. This course has two parts. In the first, students are exposed to current theories that underlie computational approaches to the study of motor control and are provided with a general background on sensorimotor control and learning. The second part of the course is dedicated to studying haptic function. With a view to training students to adopt empirically-grounded methods in the study of haptic function and of its deficits, the course utilizes a multidisciplinary approach to expose them to the basic properties of the mechanics of tissues, the principles of neural organization and behavioral findings relevant to its sensory and motor aspects. In the laboratory component of the course, students replicate basic results in sensorimotor learning and performance and are exposed to a series of haptic illusions.

Course: Introduction to Robotics

Katherine J. Kuchenbecker

This graduate-level course presents the fundamental kinematic, dynamic, and computational principles underlying most modern robotic systems. The main topics of the course include rotation matrices, homogeneous transformations, manipulator forward kinematics, manipulator inverse kinematics, jacobians, path and trajectory planning, robotic sensing and actuation, feedback control, haptic interfaces, and teleoperation. The material presented in lectures is reinforced with hands-on homework assignments and lab exercises that include controlling a robot arm and programming of a haptic interface. For the latter, students do assignments that involve the Phantom Premium, an impedance-type haptic interface with three actuated rotational joints that has been retrofitted to work with MATLAB. The first haptics assignment involves inspecting the Phantom device and associated data sheets to measure its link lengths, calculate its gear ratios, derive its forward kinematics, and understand the details of its sensors and actuators. The next haptics assignment gives the students the opportunity to use this low-level infrastructure to create haptic virtual environments. An example of this is shown in the figure where after testing a demonstration that places the user inside a three-dimensional virtual box using Hooke’s Law force feedback, students program a virtual sphere and a virtual viscous damping field. Students program and test a variety of haptic virtual environments using a Phantom Premium and MATLAB.