Soft Robotics for Humanity
Syllabus (version 09.24.19)

Course Description
While traditional robotic manipulators are constructed from rigid links and simple joints, a new generation of robotic devices are *soft*, using flexible, deformable materials. The growing field of soft robotics offers exciting new approaches for bio-inspired design, fast and low-cost prototyping, and integrating novel materials with digital control. These soft robots have the potential to benefit humanity in a wide variety of applications, ranging from medical devices that interface gently with the human body to robot explorers for remote or dangerous environments.

Students in this class will learn how to design, make, and test soft robots. We will discuss what makes a robot soft, the tools and design approaches for creating soft robots, and what advantages and challenges result from using soft materials and compliant structures. Students will get hands-on experience building soft robots using various materials, actuators, and programming to create robots that perform different tasks. Through this process, students will gain an appreciation for the capabilities and limitations of bio-inspired systems, use design thinking to create novel robotic solutions, and gain practical interdisciplinary engineering skills related to robotics, mechanical engineering, and bioengineering. The final project will involve creating a soft robot to accomplish a task that benefits people. *Pre-requisites: high-school physics (non-calculus) and at least a little familiarity programming. Building and mechatronics experience are not required!*

Instructor
Prof. Allison Okamura, Bldg. 550 Room 107, aokamura@stanford.edu, office hours to be scheduled
Course Design: Laura Blumenschein (lblumens@stanford.edu)
Course Development Assistants:
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Course Time/Location
Meeting time: Tuesdays and Thursdays 1:30-2:50 pm
Location: Bldg. 520, Room 145 (d'Arbeloff Teaching Lab)
Course website: http://me23n.stanford.edu
There is no textbook for this class

Objectives
By the end of this class, you will:
1. Be familiar with the growing field of soft robotics
2. Understand the design concepts behind compliant design and bio-inspired design
3. Develop designing and prototyping skills to create and control soft robotic systems
4. Design and build a new soft robotic system that accomplishes a beneficial task

Administrative
- Grading: The class is graded on letter grade basis. To earn an A in the course, you must **complete all laboratory assignments on time (50%)**, **complete a successful final project and give a**

demonstration/presentation (40%), and **participate actively in all classes (10%)** or arrange a suitable makeup for up to one session in advance.

- Assignments: Laboratory assignments will be completed in class, and done as homework if not completed in class. Project activities and presentations will also be required in the latter half of the course.
- Absences/Make-ups: Attendance at all sessions and completion of all assignments and project are required to receive full credit for the course. (If you know up front you have a conflict, plan ahead and let Allison know ASAP!)
- Students with documented disabilities: Students with Documented Disabilities: Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is made. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 723-1066, URL: http://studentaffairs.stanford.edu/oae).

Tentative Schedule

Week	Date	Topic(s)	
1	Tue 9/24 Thu 9/26	Introduction to soft robotics, compliance, and bio-inspiration	
2	Tue 10/1 Thu 10/3	Localized compliance and bending, shape memory alloys	Lab 1: SMAs and origami robots
3	Tue 10/8 Thu 10/10	Particle jamming, creating stiffness change	Lab 2: Particle jamming gripper
4	Tue 10/15 Thu 10/17	Air powered robots and pneumatic artificial muscles (sPAMs, IPAMs, etc.)	Lab 3: Pneumatic artificial muscles
5	Tue 10/22 Thu 10/24	Fabrics for soft robots, wearable robots, fiber-wrapped actuators	Lab 4: Textile robot
6	Tue 10/29 Thu 10/31	Silicone elastomers and molding, pneumatic networks	Lab 5: Elastomeric robots
7	Tue 11/5 Thu 11/7	Soft sensors for strain, force, contact; embedding sensors in soft systems	Lab 6: Soft strain sensors
8	Tue 11/12 Thu 11/14	Project introduction Work on projects	Project proposals
9	Tue 11/19 Thu 11/21	Work on projects Work on projects	
Thanksgiving Recess			
10	Tue 12/3 Thu 12/5	Work on projects Project demonstrations	 Project demonstration