COURSE SYLLABUS SPRING 2015

AA 280: Smart Structures

Room & Schedule: Building 90, Rm. 92Q, Mon. & Wed. 2:15-3:45 p.m.
Course Website: http://xlab.stanford.edu/aa280

Instructor: Prof. Debbie G. Senesky
dsenesky@stanford.edu
Office Hours: Fri. 2:00-3:00 p.m. in 254 Durand Building

COURSE DESCRIPTION

Smart materials and structures can monitor their state of health, automatically heal internal fractures and adapt to environmental changes. Making structures smarter leads to engineering systems (e.g. aircraft, automotive and biomedical) that are lightweight, more aerodynamic and have increased operation lifetimes. In this course, current approaches for designing and implementing smart structures in real-world applications will be reviewed. In addition, students will analyze constitutive equations that model the behavior of piezoelectric ceramics, electroactive polymers (artificial muscle) and shape memory alloys. Students from various disciplines of engineering can benefit from this course. This course presumes the student is already familiar with a basic mechanics of materials. AA 240A is a highly recommended (but not mandatory) prerequisite.

By the end of the course students will be able to:

1. Analyze the behavior of smart materials such as piezoelectric ceramics, shape memory alloys and electroactive polymers
2. Identify state-of-the-art approaches for making structures smarter (e.g. health assessment, self heal and adapt to environment)
3. Exercise oral communication skills by presenting to peers and obtaining feedback

TENTATIVE LECTURE SCHEDULE

Week 1 (Mon., Mar. 30 & Wed., Apr. 01)
Lecture 1: Introduction to course structure; Definition of smart structures
Lecture 2: Learning from nature; Bio-inspired materials and structures
**Homework 1 Due

Week 2 (Mon., Apr. 06 & Wed., Apr. 08)
Lecture 3: Learning from nature, continued; Self-healing materials and structures
Lecture 4: Review of elasticity; Introduction to piezoelectric materials
**Homework 2 Due
**Select topic for midterm presentation

Week 3 (Mon., Apr. 13 & Wed., Apr. 15)
Lecture 5: Piezoelectric materials, continued
Lecture 6: Piezoelectric sensors and actuators

Week 4 (Mon., Apr. 20 & Wed., Apr. 22)
Lecture 7: Introduction to electro-active polymers (artificial muscle)
Lecture 8: Electro-active polymers, continued; Introduction to shape memory alloys
**Homework 3 Due
Week 5 (Mon., Apr. 27 & Wed., Apr. 29)
Lecture 9: In class presentations
Lecture 10: In class presentations
**Midterm presentations in class

Week 6 (Mon., May 04 & Wed., May 06)
Lecture 11: Shape memory alloys, continued; Magnetostrictive materials
Lecture 12: Introduction to sensors; Sensor materials
**Homework 4 Due
**Select topic for final presentation

Week 7 (Mon., May 11 & Wed., May 13)
Lecture 13: Sensors, continued
Lecture 14: Sensors, continued

Week 8 (Mon., May 18 & Wed., May 20)
Lecture 15: Sensor networks for structural health monitoring
Lecture 16: Wireless sensor networks and energy harvesting
**Homework 5 Due

Week 9 (Mon., May 25 & Wed., May 27)
Lecture 17: Memorial Day (holiday, no class)
Lecture 18: Guest lecture, TBD

Week 10 (Mon., Jun. 01 & Wed., Jun. 03)
Lecture 19: In class presentations
Lecture 20: In class presentations; Review of course materials
**Final presentations in class

COURSE ASSIGNMENTS & ACTIVITIES

Homework (30 %)
A series of homework sets will be assigned throughout the quarter. These homework assignments will allow students to demonstrate their mastery of the theoretical principles presented in class.

Midterm presentation (30 %)
Students will give a short oral presentation on a topic during the lecture period. In this assignment/activity, students will select a topic and find a recent (circa 2005 to 2013) journal paper on the topic. Students will review the topic and the selected journal article with the instructor (Prof. Senesky) at least 2 weeks before the scheduled presentation. The oral presentations will introduce a topic, describe the principle of operation and propose future directions for the specific topic. Students watching the presentations will be asked to provide constructive feedback to the presenters through written evaluation.

Final project (40 %)
Students will give an oral presentation (20%) and submit a report (20%) on a topic. In this assignment/activity, students will select a topic and find recent (circa 2005 to 2013) journal papers on the topic. Students will review the topic and the selected journal articles (3 to 5) with the instructor (Prof. Senesky) at least 2 weeks before the scheduled presentation. The oral presentation and final report will introduce the topic, describe the principle of operation and propose future directions for the specific topic.
MAIN TEXTBOOK


In addition to the main textbook, the instructor will provide supplemental reading material on the AA 280 CourseWork website (https://coursework.stanford.edu/portal/Sp14-AA-280-01).

OPTIONAL TEXTBOOKS
(Reference Only, No Purchase Required)


ON CAMPUS RESOURCES

Oral Communication Program at the Center for Teaching and Learning (CTL): Oral communication coaching is available to all Stanford students. Highly-trained peer Oral Communication Tutors (OCTs) are available to provide coaching on all stages of the presentation process. OCTs can also advise on designing effective visual aids, reducing speech anxiety, and practicing for job interviews.

CTL Website: http://ctl.stanford.edu/speaking/oralcomm.html

Engineering Library (Terman): The Frederick Emmons Terman Engineering Library (in Huang Engineering Center) supports the research and teaching of the School of Engineering and Physics and Applied Physics Departments, as well as the research labs and institutes of the following departments: Aeronautics & Astronautics, Bioengineering, Civil & Environmental Engineering, Computer Science, Electrical Engineering, Management Science & Engineering, Materials Science & Engineering, and Mechanical Engineering. Library space and services are designed to foster collaboration among students and faculty. Subject librarians are assigned as liaisons to each department to facilitate discovery, retrieval, and integration of print and digital information.

Terman Library Website: http://library.stanford.edu/libraries/englib/about
Guide on searching for articles: http://library.stanford.edu/guides/find-articles