University of Toronto – Department of Mechanical and Industrial Engineering

MIE1740H1S Smart Materials and Structures **Syllabus**

Course Outline

Instructors
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Office Hours
Per email request

Course Schedule
- Lectures
  Tuesdays, starting Jan. 11
  Hours: 15:00-17:00

Contact Hours
- 0.5 credits
- Lectures:
  2 hrs x 12 wks/term

Prerequisites
N/A

Course Website
Quercus Portal

Important Dates

Project Due Dates
Interim Report & Presentation
Feb 15, 2022

Final Report & Presentation
Apr. 5, 2022

Final Exam

TBD, 2022

Course Description

Smart materials are a novel class of materials characterized by new and unique properties that can be altered in response to environmental stimuli. They can be used in a wide range of applications since they can exceed the current abilities of traditional materials especially in environments where conditions are constantly changing. This course is designed to provide an integrated and complete knowledge to smart materials and structures, which makes a strong foundation for further studies and research on these materials. Topics include: structure, processing, properties of smart materials; Dependence of properties on structure; Processing and design; Mechanical, thermal, electrical, magnetic and optical smart materials systems; such as piezoelectrics, ferroelectrics, electrostrictive materials, shape memory materials, magnetostrictive materials; Chemical and Optical activated materials; Design, and optimization of smart materials systems using CAD and FEA software packages.

References

- SPIE Smart Structures and Materials Proceedings 1999-2020
- ASME Smart Materials and Adaptive Structures and Intelligent Systems proceedings 2009-2020
- K. Otsuka and C. M. Wayman, Shape Memory Materials, Cambridge Press 1999.
- M Shahinpoor and Hans-Jorg Schneider, Intelligent Materials, Royal Society of Chemistry Press 2007.
- Bar-Cohen, Electroactive Polymer (Eap) Actuators as Artificial Muscles, SPIE Press 2005
- Gandi, M.V. and Thompson, B.S., “Smart Materials and Structures,” Chapman & Hall, UK, 1992,
- Culshaw, B., “Smart Structures and Materials,” Artech House, Inc., Norwood, USA, 1996.
- Leo, D. Smart Materials Systems, Wiley 2007

Evaluation

- Midterm Presentation and Interim report (10%)
- Final Project Reports and Presentations (40%)
- Final examination (50%)
- Total: 100 %

Project Guideline

Group Projects, presentation, and electronic report

Academic Policy	Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the General Academic Regulations on Academic Integrity, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty. https://www.academicintegrity.utoronto.ca/
Late Penalties	20% penalty for each portion of 24-hour period past the deadline.

Learning Objectives

At the end of the course, students should be able to:

- Understand the key practical theory with the operation principles of smart materials, their manufacturing, properties and their applications
- Address the key challenges and obstacles with manufacturing of different smart materials
- Design and justify appropriate materials for specific application related to smart structures

Course Schedule

Lecture Topics	Subject
Introduction	- Course Administration & Overview - Introduction to smart materials and structures - Course Objectives and Outcomes
Electrically Activated Materials: Piezo	- Piezoelectricity - Piezoresistivity - Ferroelectricity
Electrically Activated Materials: Dielectrics	- Dielectric Materials - Electrostrictive Materials - Electrets - Electrorheological Fluids
Electrically Activated Materials: Ionic	- Conductive Polymers - Ionomeric Polymer-Metal Composites - Carbon Nanotubes
Thermally Activated Materials	- Shape memory alloys - Classification - Transformation - Ni-Ti Alloys
Thermally Activated Materials	- Shape memory ceramics - Shape memory polymers - Applications
Magnetic Activated Materials	- Magnetostriction - Magnetorheological Fluid - Superconductors
Chemically Activated Materials	- Chemical Gels - Self healing materials
Optically Activated Materials	- Optically activated polymers - Azobenzene - Liquid Crystals