MIE 1809H Advanced Mechatronics (Winter 2023)

1. Instructors:

Professor Ridha Ben Mrad
Office: MC224, Tel: 946-0689
e-mail: rbenmrad@mie.utoronto.ca
Office hour reserved for MIE1809H:
Wednesdays 4-5 (additional times can be arranged through appointments)

Dr. Eswar Prasad
Founder, Sensor Technology Limited
Chairman, Piemades, Inc.
Email: eswar.prasad@theprasads.ca

Guest lecturers: Dr. Sailu Nemana, VP R&D, Sensor Technology Ltd.
Mr. Neelesh Bhadwal, PHD student, University of Toronto

2. Marking Scheme:

Project:	80%
Final Exam:	20%
Total:	100%

In this course, there will be no graded assignments or tests returned before the last date to drop courses. Students should be aware of this in making any decision whether or not to remain in the course past the drop date. No requests for late withdrawal will be supported on the grounds that insufficient feedback was available before the drop date.

3. Lectures:

2-4 pm (eastern time zone) Wednesday Room: BA 2165
As needed an online link is provided in case any of the sessions needs to be presented online:
Zoom Meeting link: https://utoronto.zoom.us/j/84357295637
Meeting ID: 843 5729 5637
Passcode: 762390

4. Final exam:

You are allowed one 8.5”x11” aid sheet into the final exam. Calculators are allowed. No additional material is allowed.

5. Project description and requirements:

- The project is selected by the students from the projects listed in Sessions 11 and 12. Projects are developed in groups of 2. Other projects can also be selected in the following areas:
  - Development of precision sensors
  - Development of precision actuators
  - Implementation of precision systems and issues addressed.
- The project report is submitted at the beginning of Session 12 in technical paper format. The report should not exceed 10 pages using single line spacing. Powerpoint presentations are also

submitted at the beginning of the presentation session. Each presentation is 20 minutes long and up to 10 minutes for questions.

- The project presentation and report are marked based on: presentation (written and oral), complexity of the work done, and technical correctness.
- The syllabus shows a list of suggested projects. Other projects are also possible.
- The project reports and presentations need to present a summary of state of the art on the technology, describe the concepts and basic forms of the technology and provide some ideas for future development.

Tentative Schedule

February 8	Presentation of project outlines
February 22	Reading week – no lecture
March 22	Final exam (up to 90 minutes)
March 29	Presentation of projects
April 5	Presentation of projects/Project reports due

Tentative Course Outline (Major Headings)

Session 1: Course introduction and rules, Smart materials and their characteristics. (R. Ben Mrad and E. Prasad – January 11)

Session 2: Piezoelectric devices and their applications – Part I (E. Prasad – January 18)

Session 3: Piezoceramic materials and their processing (S. Nemana – January 25)

Session 4: Piezoelectrics and their properties (R. Ben Mrad – February 1)

Session 5: Brief student presentations of their projects outline (up to 5 minutes per project); Energy harvesting using piezoelectrics (R. Ben Mrad – February 8).

Session 6: Modeling of non-linearities in piezoceramics and real-time compensation of the nonlinearities for high precision applications (R Ben Mrad – February 15)

Session 7: Precision piezoceramic sensors – case study (E. Prasad – March 1)

Session 8: Piezoelectric precision linear and rotary motors (R. Ben Mrad – March 8)

Session 9: Thin film piezoelectrics with applications (N. Bhadwal – March 15)

Session 10 (March 22**):** Final exam

Session 11 (March 29**)**: Student presentations for suggested projects
Group 1 presentation – Piezoceramics for energy harvesting
Group 2 presentation - Other energy harvesting technology
Group 3 presentation - Piezo ultrasonic motors
Group 4 presentation – Power requirements of piezo actuators

Session 12 (April 5**)**: Student presentations for suggested projects, final reports due for all projects
Group 5 presentation – Multi-axis accelerometers, their capabilities, and their applications
Group 6 presentation - MEMS gyros, their capabilities, and their applications
Group 7 presentation - A survey of piezoelectric sensors and their characteristics
Group 8 presentation - Thin film piezoceramics