University of Victoria Engineering

Department of Mechanical Engineering

COURSE OUTLINE

MECH466 – Microelectromechanical Systems (MEMS)

Term – SUMMER 2015 (201505)

Instructor:

Dr. Nikolai Dechev
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Office Hours:

Days: Thursday
Time: 1:00 – 2:00 PM
Location: EOW 517

Teaching Assistants:

Mr. Basem Badr	Email: bbadr@uvic.ca	Office: ELWA247 (by appointment)
Mr. Henry Sukardi	Email: henrysukardi@gmail.com	Office: ELWA247 (by appointment)

Course Website:
http://www.engr.uvic.ca/~mech466

Course Overview:

MECH 466 covers the principles of MEMS operation theory, MEMS design and fabrication. The course begins with an overview of MEMS and techniques used to fabricate MEMS. We cover the important question of "why use small devices" using scaling law principles. A significant portion of the course examines how micro-mechanical structures are used for sensing and actuation, including the domains of: electrostatics, micro-thermodynamics, piezoresistive, piezoelectric and micro-magnetic devices. Following this, advanced micro-fabrication techniques are discussed, along with advanced MEMS applications of micro-fluidics; micro-optics; microassembly and packaging. Throughout the course, various case studies of MEMS device operation, design, and micro-fabrication are discussed.

Learning Outcomes:

Upon successful completion of this course the student will be able to:

- Understand the operational theory of common MEMS sensors and MEMS actuators.
- Identify situations where MEMS sensors and actuators would be ideal for application to various products.
- Apply the scaling-laws to determine if MEMS devices would perform better than existing non-microscale devices.
- Analyze the engineering science and physics of MEMS devices at the micro-scale including: electrostatics, thermodynamics, piezoresistive, piezoelectric, magnetism, microfluidics, and optics.
- Understand the fabrication methods used to build/construct MEMS.
- Develop new ideas and applications for MEMS devices.

Tentative Schedule of Lecture Topics:

The lectures will cover the following material:

Lecture #:	Topic:	Textbook Chapter:
1	Introduction & Basics of Microfabrication	1.0 – 1.3
2	Scaling Laws & Basics of Microfabrication	2.0 – 2.5
3	Basics of Semiconductors and Resistivity	3.0 – 3.2
4	Basic Concepts of Stress and Strain	3.2 – 3.4
5	Beam Mechanics: Deflection and Torsion, Introduction to Stiction	3.4 – 3.9
6	Electrostatic Sensing and Actuation	4.0 – 4.2
7	Electrostatic Sensing and Actuation	4.2 – 4.5
8	Thermal Sensing and Actuation	5.0 – 5.5
9	Thermal Sensing and Actuation	5.0 – 5.5
10	Piezoresistivity	6.0 – 6.4
11	Piezoresistivity	6.0 – 6.4
12	Piezoelectric Materials, and Piezoelectric Sensing and Actuation	7.0 – 7.3
13	Piezoelectric Materials, and Piezoelectric Sensing and Actuation	7.0 – 7.3
14	Magnetic Actuation	8.0 – 8.2
15	Magnetic Actuation	8.2 – 8.3
16	Microfabrication Technologies, Surface Micromachining	10.0 – 11.3
17	Advanced Microfabrication Technologies: LIGA, HARM, Assembly	11.5 + Sup. Notes
18	Stiction and Polymer MEMS	11.4 + 12.0 – 12.3
19	Bio MEMS	Sup. Notes
20	Microfluidics	13.0 – 13.2
21	Microfluidics	13.2 – 13.4
22	Optical MEMS	15.0 – 15.2
23	Optical MEMS	15.0 – 15.2

Course Format:

- **Lectures:** Lecture hours will be devoted to introducing, reviewing, and discussing the course material. It is the responsibility of the student to attend lectures and observe the progress of the course. Students should note that the assignment, mid-term exam and final exam scheduling provided in this course outline are tentative, and that notice regarding any changes will be given during the lectures.
- **Laboratories:** The laboratories will provide 'hands on' experience in the investigation of MEMS devices using microscopy equipment and micromanipulation equipment. The students must attend and perform the laboratory sessions. Laboratory assignments are due one week after the lab, and may be placed in the MECH 466 **Drop Box, adjacent to ELW A144**.

Lab #:	Dates:	Due Dates:	Topic:
1	May 27 & May 29	June 5	Electrostatic Actuators
2	June 5 & June 10	June 19	Thermal Actuators
	June 17 & June 19		SEM (Scanning Electron Microscope) Demo
3	July 8 & July 10	July 17	MEMS Material Properties & Micromanipulation
4	July 17 & July 22	July 31	Microassembly Lab

- **Assignments:** The assignments will cover sample problems from the textbook, and other material. It should be noted that completion of sample problems from the textbook will assist students in preparing for the mid-term exam and final exam. Students are encouraged to review additional textbook problems, beyond those assigned. Homework will be assigned on the following dates, are due by the following dates, and may be placed in the MECH 466 **Drop Box, adjacent to ELW A144**:

Assignment #:	Assigned:	Due Date:
1	May 22	May 29
2	June 5	June 12
3	July 3	July 10
4	July 17	July 22

LATE ASSIGNMENTS OR LATE LABORATORY REPORTS, WILL NOT BE ACCEPTED

- **Tutorials:** The tutorials are scheduled on an "as needed" basis to provide students with extra help regarding the class material. The tutorials are not compulsory, and students may attend based on their own needs.
- **Office Hours:** Students are welcome to make inquiries regarding lecture material, assignment problems, and project work at any time. To ensure the instructor's availability, office hours have been established once per week as indicated above. Beyond this time, students should contact the instructor in advance by email, to set a meeting time. Students are also encouraged to discuss course related material with the course TA, who may be able to provide assistance.
- **Email Policy:** Due to the volume of email communication, the instructor will attempt to respond to emails within 24-48 hours. Please keep email communication short and clear.

For Success the Student Should:

- Attend all of the Lectures and be prepared to participate in active discussions about the topics. Deriving value from this course depends upon being actively engaged.
- Be prepared to devote approximately 3 hours per week outside of the lecture times.
- Successfully complete and master all the assignments "independently."
- Successfully completed all the laboratories in a team-based environment.
- Complete all assigned readings and homework exercises.

Lecture Times:

A-Section(s): A01 / CRN 31598
Days: Monday and Thursday
Time: 11:30 AM to 1:00 PM
Location: See Table Below

Room #:	Dates
DTB A102	May 11-21, June 1-15, 22-29, Jul 9, 16, 23, 30.
MAC D288	May 25, 28
COR B108	June 18
ELL 167	July 6, 13, 20, 27

Required Text

Title: Foundations of MEMS, 2nd Edition **Author:** Chang Liu **Publisher:** Prentice Hall **Year:** 2004

Assessment:

➢ Assignments (4)	15%	Date: See Table
➢ Laboratory Reports (4)	15%	Date: See Table
➢ Mid-term Exam*	30%	Date: June 24th, Room, Time
➢ Final Exam*	40%	Date: TBA

Note: A passing grade is required for the combined exam mark, consisting of the Mid-term Exam and the Final Exam, in order to pass the course.

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

There will be no supplemental examination for this course.

Note to Students:

Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Chair's Secretary to set up an appointment.

Accommodation of Religious Observance
See entry in current Undergraduate Calendar

Policy on Inclusivity and Diversity
See entry in current Undergraduate Calendar

Standards of Professional Behaviour

You are advised to read the Faculty of Engineering document Standards for Professional Behaviour in current Undergraduate Calendar, which contains important information regarding conduct in courses, labs, and in the general use of facilities.

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult entry in current Undergraduate Calendar for the UVic policy on academic integrity.

© Course Lecture Notes