# Course Outline (W2020)

## BME804: Design of Bio-MEMS

### Instructor(s)

Maryam Navi [Coordinator]
Office: ENG 450
Phone: TBA
Email: maryam.navi@ryerson.ca
Office Hours: Thursdays 11:00 AM - 12:00 PM

### Calendar Description

Biophysical and chemical principles of biomedical microelectromechanical systems (bioMEMS) for the measurement of biological phenomena and clinical applications. micro-and nano-scale devices for the manipulation of cells and biomolecules. Topics include solid-state transducers, optical transducers, electrochemical transducers, biomedical microelectronics, microfluidics, and hybrid integration of microfabrication technology.

### Prerequisites

BME 674 and EES 612 and BME 423

### Antirequisites

None

### Corerequisites

None

### Compulsory Text(s):


### Reference Text(s):


### Learning Objectives (Indicators)

At the end of this course, the successful student will be able to:

1. Understand the biophysical and chemical principles to design biomedical microelectromechanical systems (BioMEMS) for measurement of biological phenomena and to design solutions to biomedical problems. (1c)
2. Model and test BioMEMS components and devices through software simulations (using Coventorware software) and critically evaluate the implications of component/device parameters modifications on overall design, independently and in lab/project teams. (2b), (3a), (5a), (6a)
3. Understand, apply and critically evaluate the design, fabrication, and operation of BioMEMS components (e.g. optical transducers, electrochemical transducers, biomedical electronics, microfluids, hybrid integration of microfabrication technology) to address medical issues and applications. (4b), (12b)
4. Communicate an understanding of fundamental theoretical and practical principles and critical evaluation of BioMEMS designs through written laboratory reports, written assignments and oral project presentations evaluated on grammar, completeness, clarity and design innovation. (7a), (7b), (7c)

**NOTE:** Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).

### Course Organization

3.0 hours of lecture per week for 13 weeks
2.0 hours of lab/tutorial per week for 12 weeks

### Teaching Assistants

Huma Inayat  inayathu@ryerson.ca  Wednesday 8:00 - 10:00 AM
Michael Nigro  michael.nigro@ryerson.ca  Wednesday 12:00 - 2:00 PM and Monday 12:00 - 2:00 PM
Labs: held in ENG 306
## Course Evaluation

<table>
<thead>
<tr>
<th>Theory</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm Exam</td>
<td>4 Labs (5% each)</td>
</tr>
<tr>
<td>25 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Final Exam</td>
<td></td>
</tr>
<tr>
<td>35 %</td>
<td></td>
</tr>
<tr>
<td>Course Project Final Report</td>
<td></td>
</tr>
<tr>
<td>10 %</td>
<td></td>
</tr>
<tr>
<td>Course Project Oral Presentation</td>
<td></td>
</tr>
<tr>
<td>10 %</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

**Note:** In order for a student to pass a course with "Theory and Laboratory" components, in addition to earning a minimum overall course mark of 50%, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the "Course Evaluation" section for details on the Theory and Laboratory components.

## Examinations

- **Midterm exam** in Week 7 of the course on February 27, will be 2 hours, closed book and will cover all material from Weeks 1-6.
- **Final exam** during exam period will be three hours, closed-book and will cover all material from Weeks 1-13.

## Other Evaluation Information

- **Labs:** Students will run labs every week starting from the 2nd week. All labs will be related to the design and simulation of bioMEMS components/devices using the software package of Coventorware. The laboratory manuals will be posted on course shell on D2L. Each lab will worth 5% and will be marked based on attendance and the lab report that accompanies each lab.

- **Lab reports:** For labs 1-3, each lab group must submit one written lab report per lab within one week of completing the lab (to the TA at the start of the next lab.) Note that all process files are to be handed in with lab write-ups.

- **Course Project:** Students will complete a course project on a topic of their choosing. Students will work in groups of up to 4 members. Groups must be emailed to the course instructor by the end of week 1 (Friday at 3pm). Topic selection will occur by the 3rd week of the term and must be approved by the course instructor (topics emailed by 3pm Friday). Details of the term project will be given during class and posted on the BME804 course shell. Each group will submit a final 5-page report of the term project design at the end of the term worth 10% (due the last week of term, April 9, 2020 by 3pm to the course instructor). Each group will present their design in weeks 12 or 13 of the course, in a 10 minute oral presentation worth 10%.

## Other Information

- **Lectures:** Thursdays 8:00-11:00 AM, KHE 225

## Course Content

<table>
<thead>
<tr>
<th>Week</th>
<th>Hours</th>
<th>Chapters / Section</th>
<th>Topic, description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
<td>Lecture Topics: Introduction to MEMS and BioMEMS. Introduction to MEMS and their applications including medical applications - proteomics - DNA biosensor/transducer - biocompatibility - Industry standards (FDA and ISO 10993).</td>
</tr>
<tr>
<td>Week</td>
<td>Lecture Topic</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lecture Topic: Silicon Microfabrication Part I. Mask creation - silicon wafer preparation - Thinfilms deposition such as SiO2 resist (positive or negative) application - UV exposure and development - etching methods - resist stripping - inspection with profilometer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Lecture Topic: Microfluidic Principles Part I. Microfluidics lab-on-a-chip - silicon and polymer material.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Midterm Exam (2 hours closed book covers chapters 1-5 in class)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Lecture Topic: Clinical Laboratory Medicine. Antibodies - chemistries - hematology - immunology - microbiology etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lecture Topic: Packaging power and safety. System integration - RF safety - data transmission. Course Project: Project Presentations (in class)

Course Project: Project Presentations (in class)

Laboratory/Tutorials/Activity Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Lab</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-4</td>
<td>T1</td>
<td>Introductory Tutorial – Introduction to ConventorWare</td>
</tr>
<tr>
<td>5-6</td>
<td>1</td>
<td>Lab 1 - Electrostatic 2D micro-mirror design and simulation</td>
</tr>
<tr>
<td>7-9</td>
<td>2</td>
<td>Lab 2 - Electro-thermal micro-gripper Simulation</td>
</tr>
<tr>
<td>10-12</td>
<td>3</td>
<td>Lab 3 – Micro pumps</td>
</tr>
</tbody>
</table>

Policies & Important Information:

1. Students are required to obtain and maintain a Ryerson e-mail account for timely communications between the instructor and the students;
2. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented;
3. Assignments, projects, reports and other deadline-bound course assessment components handed in past the due date will receive a mark of ZERO, unless otherwise stated. Marking information will be made available at the time when such course assessment components are announced.
4. Refer to our Departmental FAQ page for information on common questions and issues at the following link: [https://www.ee.ryerson.ca/guides/Student.Academic.FAQ.html](https://www.ee.ryerson.ca/guides/Student.Academic.FAQ.html).

Missed Classes and/or Evaluations

When possible, students are required to inform their instructors of any situation which arises during the semester which may have an adverse effect upon their academic performance, and must request any consideration and accommodation according to the relevant policies as far in advance as possible. Failure to do so may jeopardize any academic appeals.

1. Health certificates - If a student misses the deadline for submitting an assignment, or the date of an exam or other evaluation component for health reasons, they should notify their instructor as soon as possible, and submit a Ryerson Student Health Certificate AND an Academic Consideration Request form within 3 working days of the missed date. Both documents are available at [https://www.ryerson.ca/senate/forms/medical.pdf](https://www.ryerson.ca/senate/forms/medical.pdf). If you are a full-time or part-time degree student, then you submit your forms to your own program department or school;
2. Religious, Aboriginal and Spiritual observance - If a student needs accommodation because of religious, Aboriginal or spiritual observance, they must submit a Request for Accommodation of Student Religious, Aboriginal and Spiritual Observance AND an Academic Consideration Request form within the first 2 weeks of the class or, for a final examination, within 2 weeks of the posting of the examination schedule. If the requested absence occurs within the first 2 weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the absence. Both documents are available at [www.ryerson.ca/senate/forms/relobservformInstr.pdf](http://www.ryerson.ca/senate/forms/relobservformInstr.pdf). If you are a full-time or part-time degree student, then you submit the forms to your own program department or school;
3. Academic Accommodation Support - Before the first graded work is due, students registered with the Academic Accommodation Support office (AAS - www.ryerson.ca/studentlearningsupport/academic-accommodation-support) should provide their instructors with an Academic Accommodation Support letter that describes their academic accommodation plan.
Academic Integrity

Ryerson's Policy 60 (the Academic Integrity policy) applies to all students at the University. Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism - a serious academic offence, with potentially severe penalties and other consequences. It is expected, therefore, that all examinations and work submitted for evaluation and course credit will be the product of each student's individual effort (or an authorized group of students). Submitting the same work for credit to more than one course, without instructor approval, can also be considered a form of plagiarism.

Suspicious of academic misconduct may be referred to the Academic Integrity Office (AIO). Students who are found to have committed academic misconduct will have a Disciplinary Notation (DN) placed on their academic record (not on their transcript) and will normally be assigned one or more of the following penalties:

1. A grade reduction for the work, ranging up to an including a zero on the work (minimum penalty for graduate work is a zero on the work);
2. A grade reduction in the course greater than a zero on the work. (Note that this penalty can only be applied to course components worth 10% or less, and any additional penalty cannot exceed 10% of the final course grade. Students must be given prior notice that such a penalty will be assigned (e.g. in the course outline or on the assignment handout);
3. An F in the course;
4. More serious penalties up to and including expulsion from the University.

The unauthorized use of intellectual property of others, including your professor, for distribution, sale, or profit is expressly prohibited, in accordance with Policy 60 (Sections 2.8 and 2.10). Intellectual property includes, but is not limited to:

1. Slides
2. Lecture notes
3. Presentation materials used in and outside of class
4. Lab manuals
5. Course packs
6. Exams

For more detailed information on these issues, please refer to the Academic Integrity policy (https://www.ryerson.ca/senate/policies/pol60.pdf) and to the Academic Integrity Office website (https://www.ryerson.ca/academicintegrity/).

Important Resources Available at Ryerson

1. The Library (https://library.ryerson.ca/) provides research workshops and individual assistance. Inquire at the Reference Desk on the second floor of the library, or go to library.ryerson.ca/guides/workshops
2. Student Learning Support (https://www.ryerson.ca/studentlearningsupport) offers group-based and individual help with writing, math, study skills and transition support, and other issues.