

Microfluidic Design and Simulation

ME EN 7960 and BIOEN 6900

Class Time: Tuesday and Thursday from 3:40 PM – 5:00 PM in EMCB 112
Instructor: Dr. Bruce Gale
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Office Hours: 10 AM -12:00 Noon Daily except Wednesday
Other times by appointment
Text: *Fundamentals and Applications of Microfluidics*, Nguyen and Wereley, Artech House, 2002,
ISBN 1-58053-343-4
Supplemental Texts: *Fundamentals of Microfabrication, 2nd Edition*, Mark Madou, CRC Press,
Microsystem Design, Stephen D. Senturia, Kluwer Academic Press, 2000.
Other relevant microfabrication texts.
Class Web Page: WebCT at <http://webct.utah.edu>

Objectives

1. To gain an understanding of microfabrication techniques used in the construction of microfluidic systems.
2. To know the major classes, components, and applications of microfluidic systems and to demonstrate an understanding of the fundamental principles behind the operation of these systems
3. To understand and be able to use tools for simulating microfluidic systems
4. To understand the unique requirements, environments, and applications of microfluidics in biomedical applications.
5. To apply knowledge of microfabrication techniques and applications to the design and simulation of a microfluidic system.
6. To make the study of biomedical microsystems enjoyable

Grading

Exam 1	15%
Final Exam	20%
Class Presentations	15%
Reports	20%
Final Project	20%
Homework	10%

Homework

Homework will be assigned occasionally during the course of the semester to assist students in preparing for exams and to ensure understanding of the presented material.

Microfluidic Design Course Reports and Presentations

The purpose of these reports is to provide all students in the course with a thorough understanding of both a microfluidic fabrication method and a standard microfluidic component. All reports and presentations will be shared with other students in the class.

General Report Guidelines

Each report should be approximately the length of a standard research paper with about 7,000 words. A standard figure counts for about 200 words. The particular format used for a report is up to the individual student. The report should focus on modern practice (i.e. year 2000 and sooner). The topic for each report will need to be approved by the instructor to insure that there is no overlap between students. The report should be well referenced and electronic versions of referenced papers, if available, should be provided to the instructor, who will post them on a course page. The report itself will also be made available to all students on the course page.

General Presentation Information

The presentation will be 15 minutes in length with an additional 5 minutes for questions. The presentation is expected to be a clear and concise overview of the findings in the report, and the student is expected to demonstrate adequate communication and presentation skills, as well as a clear understanding of the work being presented. The presentations will be graded by both the instructors and the students in the course. 50% of the presentation grade will be determined by the instructor, 40% by other students in the class, and 10% by your attendance and grading of other students presentations. Presentations need to be submitted electronically to the instructor where they will be placed on a course server.

Microfluidic Fabrication Report (Due Feb 14)

The first report will be focused on a fabrication technology for microfluidics, preferably one of an inexpensive variety. The report should give information on the development of the fabrication technology, the major applications and limitations of the technology, the specific methods for implementing the technology, and examples of the technology in use. The presentation should cover the important material developed in the report, and should provide concise conclusions so a microfluidic designer could make informed decisions based on the information you provide. Presentations will be made 2/day from January 24 – February 14.

Microfluidic Component Family Report (Due March 30)

The second report will focus on a class of microfluidic components and provide an overview on the state of the art and the history of development for that component. The report should cover the different methods for accomplishing the task of the component, the different manufacturing methods for realizing the component, and the advantages and disadvantages of the different method. Choose a component group that is not too large to cover in the proposed report length. The presentation should provide a overview of technologies available for producing the desired component, the important metrics associated with the component, and conclusions that would help a designer choose how to implement a desired component. Presentations will be made 1/day beginning February 28.

Semester Project (Due April 25)

The semester project will involve the design and simulation of an integratable microfluidic component. The component should provide an important microfluidic function and be able to be easily sized to a given designers needs. The components will be compiled into a library for designers here at the University. Intellisuite has agreed to assist in making the components scalable once we have developed the basic components. The components should be thoroughly

simulated in Intellisuite, or another suitable program if necessary. The final results will be reported on a poster for Mechanical Engineering Design Day on April 25.

Schedule

All topics listed in this handout will be covered in class. The schedule is subject to change and changes to the published schedule will be announced in class and on the web page.

Lecture	Date	Chapter	Topic
1	10-Jan	1	Microfluidics Background
2	12-Jan	2	Microfluidic Standards
3	17-Jan	2	Microfluidic Physics
4	19-Jan		Multiphysics Simulation
5	24-Jan		Microfluidic System Simulation
6	26-Jan	3	Fab for Microfluidics
7	31-Jan	3	Fab for Microfluidics
8	2-Feb	4	Experimental Flow Characterization
9	7-Feb	4	Experimental Flow Characterization
10	9-Feb	6	Microvalves
11	14-Feb	6	Microvalves
12	16-Feb	7	Micropumps
13	21-Feb	7	Micropumps
14	23-Feb	7	Micropumps
15	28-Feb	8	Microflow Sensors
16	2-Mar	9	Micromixing
17	7-Mar	9	Microreactors
18	9-Mar		Midterm Exam
	14-Mar		Spring Break
	16-Mar		Spring Break
19	21-Mar		Microscale Biotechnology
20	23-Mar	9	Microseparations
21	28-Mar		Microscale Detection
22	30-Mar		Microscale Chemical Sensors
23	4-Apr		Filters and Extraction
24	6-Apr		Digital Microfluidics
25	11-Apr		Microarrays
26	13-Apr		Microfluidic Packaging
27	18-Apr		Microfluidic Integration
28	20-Apr		Nanoscale Fluidics
29	25-Apr		Poster Session 9 AM-3 PM
30	4-May		Final Exam 3:30 -5:30 PM

Class Policies

1. Withdrawal procedures and dates are on the attached page.
2. Student records, scores, exams and homework are confidential
3. Course evaluations on or near the last day of class.
4. Attendance: Failure to attend more than 25% of the class periods will result in failure of the class unless extenuating circumstances exist.
5. Cheating and Shared Work: Cheating on in-class assignments and exams will result in a zero on that assignment. Shared work on take home assignments will result in a shared grade.
6. Other general policies are on the attached page.