Microfluidics/Nanofluidics

ME-530

Spring 2021

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Office hours: Monday-Friday 20.00-xxx (Zoom), e-mail or phone or whatsup.

Text: Fundamentals and Applications of Microfluidics, Nam-Trung Nguyen and Steven T. Wereley, 2002, ISBN 1-58053-343-4, Theoretical Microfluidics, Henrik Bruus, ISBM 978-0- 19-923508-7 and lecture notes.

Prerequisites: Graduate Standing or Senior Standing with permission.

Grading: Homework 20%, Closed-book Midterm Exam 20%, Take-Home Final Exam 20%, Term Project 20% Attendance 20%

Oral Exam will be held if necessary for doublechecking the performance. The worse grade (From the Closed-book Exam and Oral Exam grades) will be taken into consideration.

For the Closed-book exam, your webcam and microphone should be on during the exam. In the case of non-compliance with this and other declared exam procedures, your exam will be void. Make sure to check that your webcam and microphone function properly before the exam.

You must attend the synchronous Zoom lectures, recitations, etc. and real-time online exams with your SU email account.

Make up exams will be only offered when an official excuse document (such as medical report) is provided.

Course Description: Microfluidics covers the behavior, precise control and manipulation of fluids in micro scale. It has emerged only in the 1990s and is a multidisciplinary field intersecting engineering, physics, chemistry, microtechnology and biotechnology and find wide applications in the development of DNA chips, micro-propulsion, micro-thermal technologies, and lab-on-a-chip technology. Microfluidics course is designed for graduate and upper class undergraduate students to give an introduction to microfluidics technology. The following topics will be covered: 1- Overview on microfluidics, 2- Basic Fluid Mechanics and Heat Transfer, 3- Analysis and modeling of microfluidic systems with slip flows, 4- Phase change phenomena in microdomains and applications, 5- Nanofluids and nanoparticle applications, 6- Electrokinetic flows and applications, 7-Magnetofluidics, Acoustofluidics and Optofluidics with applications.

Learning outcomes:

On successful completion of the course, students will be able to:

- Gain a broad insight into microfluidics/nanofluidics technology

- Have broad information on the current literature about microfluidics/nanofluidics • Gain knowledge on important microfluidic system design guidelines

- Gain knowledge on necessary tools to analyze and model microfluidic systems

Intellectual (thinking) skills:

On successful completion, students will be able to:

- Specify appropriate fabrication methods of any microfluidic systems

- Use their knowledge on basic heat transfer and fluid mechanics to design microfluidic systems

- Design flow controlling microfluidic/nanofluidic elements

- Design microfluidics systems based on phase change phenomena

Practical Skills:

On successful completion of the course, students will be able to:

- Build and improve skills in computer tools and microfabrication techniques for their design projects

Transferable Skills:

On successful completion of the course, students will be able to:

- Develop problem solving and designing skills

- Use their knowledge design and model microfluidic systems

- Apply microfluidics/nanofluidics to biomedical and nano engineering problems

Reference Books:

- Microflows and Nanoflows: Fundamentals and Simulation, George Karniadakis, Ali Beşkök, Narayan Aluru, 2005, ISBN-10: 0-387-22197-2

- Introduction to Microfluidics, Patrick Tabeling, Suelin Chen, 2005, ISBN-10: 0-19- 856864-9 • Microfluidics for Biotechnology, Jean Berthier, Pascal Silberzan, 2006, ISBM-10: 1- 58053-961-0 • MEMS and Microsystems: Design and Manufacture, Tai-Ran Hsu, Mc Graw Hill , 2002, ISBN 0-07-239391-2 • Fundamentals of Microfabrication, Marc Madou, CRC Press, NY, 1997.

- Nadim Maluf, An Introduction to Microelectromechanical Systems Engineering, Artech House, 2000. • Microsystems Design, Stephen D. Senturia, 2001, ISBN 0792372468.

Related Journals:

- J. Microelectromechanical Systems

- Microfluidics and Nanofluidics

- J. Micromechanics and Microengineering
- Journal of Fluid Engineering
- Physics of Fluids
- Journal of Fluid Mechanics
- Lab-on a Chip
- Micro and Nanoengineering
- Scientific Reports
- Nature Communications
- Science Advances
- Microsystems and Nanoengineering

Co-operation on coursework:

It is encouraged to discuss with classmates, use texts, library materials, and other sources while doing any assignment. If a solution to a problem is found in the literature, students must provide correct citations to that literature.

For the homework assignments, every student is expected to have worked through his/her own analysis and to have written up his/her own work for submission. Under no circumstances is it permitted to present another student's work as one's own.

Term Project:

Each student/group will select one topic for the project related to this course. The project will be about a design and research project related to the topic. Technical drawing and analysis should be included, and a final design is required with fabrication efforts if possible.

The project report should be approximately 10-12 pages long and will be due to the first day of project presentations. The written report must be in the style of a review journal article (like a Journal of Microelectromechanical Systems article) having the typical format as follows: Title, Author's Name and Affiliation, Abstract, Objectives, Theory and Analysis, Technical Description, Results and Discussion and References.

Plagiarism will be severely punished and result in a "zero" grade for written portion of the term project. Project Presentations will be given to the rest of the class in the last 3 weeks of classes at regular class hours.