BMEN 4V95 Course Syllabus

Course Information

Course Number & Section:	BMEN 4V95
Course Title:	Introduction to Microfluidics in Biomedical Engineering
Term:	Fall 2025
Meeting Times:	Lectures: Tuesday & Thursday 9:00 – 9:50 am (SLC 2.304) Lab: Tuesday 1:00 pm – 3:45 pm (ECSW 3.450)
Office hours:	To be determined

Contact Information

Professor	David Schmidtke, PhD
Office Phone	972-883-5238
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Course Pre-requisites, Co-requisites, and/or Other Restrictions

Prerequisites: BMEN 1208 and ENGR 3300

Course Description

The goal of this course is to introduce students to microfluidic devices used in biomedical engineering. Students will learn the building blocks of these devices, how they are constructed, and the principles governing their operation and performance. Emphasis is placed on learning the fundamental principles of these microdevices so that students can appreciate the technical challenges and opportunities that biomedical microdevices bring to life and medical sciences. Finally, students will be able to engage in hands-on activities featuring fabrication and design of biomedical microdevices.

Student Learning Objectives/Outcomes

1. Understand commercial applications of microfluidic devices (SO 1)
2. Explain principles of laminar flow, dimensionless numbers, Navier-Stokes equations (SO 1)
3. Design and fabricate simple microfluidic devices (SO 2)
4. Perform basic microfluidic experiments and analyze experimental results (SO 6)

Required Textbooks and Materials

Required Materials: Computer with internet, webcam, and audio

Textbook: **Microfluidics and Lab-on-a-chip**, by Andreas Manz, Jonathan S. O'Connor, and Giuseppina Simone, The Royal Society of Chemistry in 2020

Suggested Textbooks:

- Introduction to Microfluidics, by Patrick Tabeling, Oxford University Press, 2010
- Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices, by Brain Kirby, Cambridge University Press, 2010

- **Fundamentals and Applications of Microfluidics** Second Edition, by Nam-Trung Nguyen Steven T. Wereley, ARTECH HOUSE, INC. 2006

Assignments & Grading Policy
Students are NOT competing for grades. The final course grade will be determined based on a weighted average from homework, exams, labs and class participation during the semester as follows:

- (10%) Homework
- (35%) Midterm Exams
- (25%) Pre-labs
- (25%) Post-labs
- (5%) Participation

The following overall course averages will ensure the corresponding grades:
100% - 90% A
89% - 80% B
79% - 70% C
69% - 60% D
59% - 0% F

Course Topics (in order of coverage):

Tentative Lecture, Lab, Assignments & Academic Calendar
Note: this is a tentative schedule and may change at the discretion of the instructor

Lecture	Date	Topic	Activity
1	Tue 08-26-25	Introduction	Lecture
Lab 0	**Tue 08-26-25**	**Overview**	Lab
2	Thu 08-28-25	Applications of Microfluidics	Lecture
3	Tue 09-02-25	Materials	Lecture
Lab 1	**Tue 09-02-25**	**Pipetting Basics – Lab Safety**	Lab
4	Thu 09-04-25	Materials	Lecture
5	Tue 09-09-25	Photolithography	Lecture
Lab 2	**Tue 09-09-25**	**Surface properties Contact Angle**	Lab
6	Thu 09-11-25	Spin Coating and Etching	Lecture
7	Tue 09-16-25	Multilayer Photolithography	Lecture
Lab 3	**Tue 09-16-25**	**Fabrication of PDMS Microfluidic devices**	Lab
8	Thu 09-18-25	Soft Lithography	Lecture
9	Tue 09-23-25	Intermolecular forces, States of matter, Continuum assumption, Governing equations, Constitutive relations.	Lecture
Lab 4	**Tue 09-23-25**	**Basic Microfluidics**	Lab
10	Thu 09-25-25	Intermolecular forces, States of matter, Continuum assumption, Governing equations, Constitutive relations.	Lecture
11	Tue 09-30-25	Gas and liquid flows, Boundary conditions, Slip theory, Transition to turbulence, Low Re flows, Entrance effects.	Lecture
Lab 5	**Tue 09-30-25**	**Image Analysis**	Lab
12	Thu 10-02-25	Gas and liquid flows, Boundary conditions, Slip theory, Transition to turbulence, Low Re flows, Entrance effects.	Lecture

13	Tue 10-07-25	Exact solutions, Couette flow, Poiseuille flow, Stokes drag on a sphere, Time-dependent flows, Two-phase flows, Thermal transfer in microchannels.	Lecture
Lab 5	Tue 10-07-25	**Laminar flow**	Lab
14	Thu 10-09-25	Exact solutions, Couette flow, Poiseuille flow, Stokes drag on a sphere, Time-dependent flows, Two-phase flows, Thermal transfer in microchannels.	Lecture
15	Tue 10-14-25	Hydraulic resistance and Circuit analysis, Straight channel of different cross-sections, Channels in series and parallel.	Lecture
	Tue 10-14-25	**Exam #1**	Lab
16	Thu 10-16-25	Hydraulic resistance and Circuit analysis, Straight channel of different cross-sections, Channels in series and parallel.	Lecture
17	Tue 10-21-25	Surface tension and interfacial energy, Young-Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect.	Lecture
Lab 6	Tue 10-21-25	**Microfluidic Mixing**	Lab
18	Thu 10-23-25	Surface tension and interfacial energy, Young-Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect.	
19	Tue 10-28-25	Surface tension and interfacial energy, Young-Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect.	Lecture
Lab 7	Tue 10-28-25	**Cell Counting and Cell Viability** **Aseptic Technique & Cell Passaging**	Lab
20	Thu 10-30-25	. Surface tension and interfacial energy, Young-Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect.	Lecture
21	Tue 11-04-25	Electrohydrodynamics fundamentals.	Lecture
Lab 8	Tue 11-04-25	**Cell Passaging and Microfluidic Cell patterning**	Lab
22	Thu 11-06-25	Electrohydrodynamics fundamentals.	Lecture
23	Tue 11-11-25	Electro-osmosis, Debye layer, Thin EDL limit, Ideal electro-osmotic flow, Ideal EOF with back pressure, Cascade electro- osmotic micropump, EOF of power-law fluids.	Lecture
Lab 9	Tue 11-11-25	**Microfluidic Cell Culture & Migration**	Lab
24	Thu 11-13-25	electrophoresis of particles, Electrophoretic mobility, Electrophoretic velocity dependence on particle size.	Lecture
25	Tue 11-18-25	electrophoresis of particles, Electrophoretic mobility, Electrophoretic velocity dependence on particle size.	Lecture
Exam 2	Tue 11-18-25	**Exam #2**	
26	Thu 11-20-25	Micropumps, Check-valve pumps, Valve-less pumps, Peristaltic pumps, Rotary pumps, Centrifugal pumps, Ultrasonic pump, EHD pump, MHD pumps.	Lecture
	Tue 11-25-25	Fall Break	Lecture
	Thu 11-27-25	Thanksgiving break	Lecture
29	Tue 12-02-25	Microflow sensors, Differential pressure flow sensors, Drag force flow sensors, Lift force flow sensors, Coriolis flow sensors, Thermal flow sensors.	Lecture
Lab 10	Tue 12-02-25	**Microfluidic Cell Culture & Migration**	Lab
30	Thu 12-04-25	Droplet generators, Kinetics of a droplet, Dynamics of a droplet, In-channel dispensers, T-junction and Cross-junction, Droplet formation, breakup and transport.	Lecture
31	Tue 12-09-25	Microparticle separator, principles of separation and sorting of microparticles, design and applications.	Lecture

Course & Instructor Policies

Make-up exams:
Missed exams without advanced notice or documented reason will receive a zero. Requests to delay an exam must be made within 1-week of the exam the exam date. Missed exams without prior notification of absence must provide documented reasons (e.g., illness with doctor's note) for a make-up exam to be provided. The email reply documenting acceptance of reason for missing or rescheduling an exam will set the time and nature of make-up exam
Late Work:
Unless otherwise specified in class or on eLearning, all assignments are due 11:59 p.m. on the indicated night. Assignments turned in after the due date and time will be assessed a penalty of 25% per 24 hours. Email the assignment to the instructor and TA directly if you experience or expect an error submitting an assignment on eLearning.

Regrading
if you think that your homework, exams, or labs have been graded inaccurately you must submit in writing a request for regarding. These grading requests must be in typed letter form (no e-mails). In your request, indicate which questions of your submission you would like regraded, and prepare a clear and concise argument why you feel I should regrade those questions. Realize that the instructors reserve the right to not only regrade the problem in question but the entire assignment, quiz, or exam. Requests for regarding must be submitted within one week of when the assignment/exam/lab was returned.

Life Policy:
Life happens and personal situations can introduce complications. Please talk to the instructor if you need assistance regarding class. The instructor wants you to succeed and early communication is key. Allowances for exceptional documented circumstances will be accepted with prior consent of the instructor. In such circumstances, late work will be dealt with on a case-by-case basis. Contact the instructor and TA by email as soon as practical if these circumstances may apply to you. The email reply documenting acceptance of reason and documentation for late work will set a new deadline.

Academic Dishonesty:
Academic dishonesty can occur in relation to any type of work submitted for academic credit or as a requirement for a class. It can include individual work or a group project. Academic dishonesty includes plagiarism, cheating, fabrication, and collaboration/ collusion. In order to avoid academic dishonesty, it is important for students to fully understand the expectations of their professors. This is best accomplished through asking clarifying questions if an individual does not completely understand the requirements of an assignment.

UT Dallas has a no-tolerance policy for plagiarism, copyright infringement, or scholastic dishonesty. Plagiarism is using another's work as your own without appropriate credit or attribution. Do not cheat. Do not copy assignments, do not post assignments or make answers public, do not work on assignments as a group unless instructed to, do not plagiarize, do not use the internet or outside sources when you are not allowed to, do not use AI, do not discuss assignments with those who are not done, or do anything else that would be construed as academic dishonesty. If the instructor suspects academic dishonesty, they will follow UTD procedures with the Office of Community Standards and Conduct from which point forward the instructor will no longer be involved in the investigation or results. The instructor will not notify a

student of a report to OCSC, nor will they discuss pending investigations with the student. Do not cheat.

Additional information related to academic dishonesty and tips on how to avoid dishonesty may be found here: https://conduct.utdallas.edu/dishonesty

You should cite any sources you reference, providing in-text citation and references, both in your written work and in your online postings. If you are uncertain about how to cite sources, the following references are useful resources to guide you." (Dr. Bill Hefley)

Guidance on citations and references:

- https://libguides.utdallas.edu/citation-resources-guide
- https://www.utdallas.edu/library/researchinstruction/websites/#citations
- https://owl.purdue.edu/owl/avoiding_plagiarism/index.html
- https://owl.purdue.edu/owl/research_and_citation/using_research/quoting_paraphrasing_and_summarizing/index.html
- https://owl.purdue.edu/owl/research_and_citation/resources.html

Email Policy and Privacy:
All official student email correspondence will be sent only to a student's UT Dallas email address and UT Dallas will only consider email requests originating from an official UT Dallas student email account. Please wait 1 business day for all email responses. If you do not receive an email within that time period, please send a follow-up email or reach out in-person.

UTD takes your privacy very seriously. The instructor is unable to email grades or discuss grades by email. Grades will be posted on eLearning and all questions regarding grades should be handled in office hours.

Classroom Citizenship:
Please be respectful of your peers at all times. Please keep discussion board comments constructive and on-topic.

Course Materials

The instructor may provide class materials that will be made available to all students registered for this class as they are intended to supplement the classroom experience. These materials may be downloaded during the course, however, these materials are for registered students' use only. Classroom materials may not be reproduced or shared with those not in class or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

Class Attendance and Participation

This course involves extensive problem solving. Successful mastery of the material requires focused effort and practice throughout the semester. Contact the instructor if you need additional help or some aspect of the course is not working well for you.

Regular and punctual class attendance is expected regardless of modality. Students who fail to attend class regularly are inviting scholastic difficulty. This also includes engaging in group or other activities during class that solicit your feedback on homework assignments, readings, or materials covered in the lectures (and/or labs). Class participation is documented by faculty. Successful participation is defined as consistently adhering to University requirements, as presented in this syllabus. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

Class Recordings

Students are expected to follow appropriate University policies and maintain the security of passwords used to access recorded lectures. Unless the Office of Student AccessAbility has approved the student to record the instruction, students are expressly prohibited from recording any part of this course. Recordings may not be published, reproduced, or shared with those not in the class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

The instructor may record meetings of this course. These recordings will be made available to all students registered for this class if the intent is to supplement the classroom experience. If the instructor or a UTD school/department/office plans any other uses for the recordings, consent of the students identifiable in the recordings is required prior to such use unless an exception is allowed by law.

Resources

Academic Support Resources: The information contained in the following link lists the University's academic support resources for all students.

Student Resources: A variety of resources are available to help students to obtain counseling, health care, and academic support.

Accommodations for Students with Disabilities

The University of Texas at Dallas is committed to providing reasonable accommodations for all persons with disabilities. The syllabus is available in alternate formats upon request. If you are seeking classroom accommodations under the Americans with Disabilities Act (2008), you are required to register with the AccessAbility Resource Center (ARC), located in the Administration Building, Suite 2.224. Their phone number is 972-883-2098, email: studentaccess@utdallas.edu and the website is https://accessability.utdallas.edu/. To receive academic accommodations for this class, please register and request services by completing the Request for Services form with the proper documentation and meet with the Director of ARC at the beginning of the semester.

UT Dallas Syllabus Policies and Procedures

The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus. Please review the catalog sections regarding the credit/no credit or pass/fail grading option and withdrawal from class.

Please go to http://go.utdallas.edu/syllabus-policies for these policies.

Comet Creed

This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:

"As a Comet, I pledge honesty, integrity, and service in all that I do."

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.