ME 382: Experiments in Micro and Nano Science and Engineering
Department of Mechanical Engineering

Class Hours: T&Th 2:00PM - 3:20PM, Tech LG62
Laboratory Hours: WF 2:00-4:00pm and 4:00-6:00pm, Tech FG74 (choose 1 session/week)
Class Instructor: Horacio Espinosa (Office: A212, Ph: 7-5989, espinosa@northwestern.edu)
Lab Instructor: Nasir Basit (Office: FG73, Phone: 7-6201, n-basit@northwestern.edu)

The objectives of this course are:

1- To provide clean room training and basic micro/nano fabrication skills
2- To provide clean room operation and microfabrication equipment knowledge
3- To build microfluidic components, with soft lithography, and image flows using fluorescent microscopy
4- To provide training and experience in the utilization of scanning probe microscopy in a variety of modes
5- To engage students in micro/nanotechnology research.

Course Schedule (Classes and Labs):

Week #	Dates/Location	Lab Title
W1	**(3/31)/Tech LG62** **(3/31)/Tech LG62**	**Class Introduction (Espinosa)** **Clean Room Safety & Protocol Training (Basit)**
W2	**(4/6)/Tech FG74** **(4/8)/Tech FG74**	Clean Room Tour and Safety Training **(Basit)** (safety glasses required for all labs) Contact Aligner training & demo **(Serkan)**
W3	**(4/13, 4/15)/Tech FG74**	Contact Aligner Operation & Hands-on individual Practice **(Serkan)**
W4	**(4/19)/ Tech LG62** **(4/20, 2/22)/Tech FG74**	**Design and Fabrication of Microchannels - Lithography with SU-8 (Serkan)** Hands-on individual Practice **(Serkan)**
W5	**(4/27, 4/29)/Tech FG74**	Design and Fabrication of Microchannels- PDMS molding **(Serkan)** Hands-on individual Practice **(Serkan)**
W6	**(5/3, 5/5)/ Tech LG62** **(5/4, 5/6)/Tech FG74**	**Theory: microchannels and micro-PIV (Espinosa)** Lab: Surface Properties and Fluid Transport in Microchannels- Contact angle measurement, flow data **(Ying)** Hands-on individual Practice **(Ying)**
W7	**(5/10)/ Tech LG62** **(5/11, 5/13)/Tech FG74**	**Theory: micro-PIV (Espinosa)** Lab: Surface Properties and Fluid Transport in Microchannels- Additional flow data acquisition/analysis **(Ying)** Hands-on individual Practice **(Ying)**
W8	**(5/17, 5/19)/ Tech LG62** **(5/18, 5/20)/Tech FG74**	**Theory: AFM principles (Espinosa)** Lab: AFM-1: Training & Hands-on Practice, tapping mode/fractal analysis **(Shaoning)** Hands-on individual Practice **(Shaoning)**
W9	**(5/24)/ Tech LG62** **(5/25, 5/27)/Tech FG74**	**Theory: AFM operation modes: Spectroscopy, Dynamic or Tapping Mode (Espinosa)** Lab: AFM-2: Material Characterization **(Shaoning)** Hands-on individual Practice **(Shaoning)**
W10	**(6/1, 6/3)/ Tech FG74**	Lab: AFM-3: Force Spectroscopy **(Shaoning)** Hands-on individual Practice **(Shaoning)**

Grading:

HW assignments	20 %
Lab participation and individual reports	60 %
Final Project	20 %

Submissions: Reports submitted only in class or labs.
Late submission: 20%/day deduction from the full score.

Recommended references:

- *Nanotribology and Nanomechanics: An Introduction* 4th Edition, B.Bhushan (Editor), Springer 2017
- *Fundamentals and Applications of Microfulidics*, N.-T. Nguyen and S. Wereley, Artech House, 2nd Edition, 2006.
- *Microsystem Design*, S. D. Senturia, Kluwer Academic Publishers, 2001.
- *Nanotribology and Nanomechanics I and II,* Bharat Bhushan (Editor), Springer, 2011
- *Scanning Probe Microscopy in Nanoscience and Nanotechnology*, B. Bhushan, Springer, 2010
- *Scanning Force Microscopy*, D. Sarid, Oxford University Press, 1991.

Other references on microsystems:

- *Fundamental of Microfabrication*, Marc Madou, CRC Press, 1997.
- *Introduction to Microelectronic Fabrication*, Richard C. Jaeger, Addison-Wesley, 1993.
- *Handbook of Nanoscience, Engineering and Nanotechnology*, edited by Gooddard III, Brenner, Lyshevski and Lafrate, CRC Press, 2002.
- *Mechanical Microsensors*, M. Elwenspoek and R. Wiegerink, Springer Verlag, 2001.
- *Silicon Micromachining*, M. Elwenspoek and H. Jansen, Cambridge Press, 1999.

Access to University Facilities:

Laboratory work will take place in NUFAB clean rooms.

Lab Evaluations:

Each student must provide a lab evaluation immediately each lab. Prof. Espinosa will distribute evaluation forms in class or via e-mail.

General Guidelines:

- Each student will need to write and turn in his/her individual report or homework. You are encouraged to work together and discuss lab problems but make sure that the work you turn in is your own.
- Late reports will be deducted at the rate of 20% per day late. Maximum grace period is until graded report is returned.
- Instructor reserves the right to raise the final grade of any student by one letter based on participation in class and laboratory sessions.
- Attendance to class and labs is required. If you cannot come, please let the instructors know in advance. You should just send e-mail.
- Feel free to meet Professor Espinosa in his office (A212) to discuss labs or any other issues at any time. You may wish to send an e-mail to schedule an appointment.