

Decoders 1.9: Introduction to Microfabrication

Style: *Individual*; Personal

To pass, you must: (i) attend all the cleanroom sessions, (ii) complete the sections of edX course and all the quizzes as outlined in the syllabus (progress will be checked and noted every week.), and (iii) define all microfabrication terms given in the classroom. By the end of Class #1, students must decide whether to register or drop the course.

Overview: In *Decoders 1.9*, cleanroom processes and fabrication techniques are aimed to be learned through lectures in class and then in cleanroom. At the end of each class, microfabrication terms are given to students to be defined. In the next class, students work together to explain these terms with associated sketches and analogies. The information is then collected in the class booklet. Students will gain hands-on experience with all six components of the microfabrication techniques including cleaning, deposition, patterning, etching, transfer printing and testing. The midterm project is to create a video of a microfabrication process (in groups of two or three) taught in the cleanroom and posted on the course website and YouTube channel. The final project is to identify a problem that can be tackled with a collective device fabricated in the cleanroom, which is the focus of *D3.0*.

- For homework, register *Micro and Nanofabrication (MEMS) course* at <https://www.edx.org/course/micro-nanofabrication-mems-epflx-memsx-0>
- [Cleanroom](#) (YellowBox) open hours will be held on Tuesdays from 9am to 11am.

Objectives:

1. To learn various cleanroom processes in the classroom setting,
2. To re-define the microfabrication terms learned in the classroom,
3. To experience the microfabrication processes in the cleanroom,
4. To create video clips of these processes with a personal style.

Schedule:

Class 1: September 4th, 2024 (E15-466 & E15-443a) – Introduction to YellowBox

Class 2: September 11th, 2024 (E15-466)

- a. Overview and introduction to microfabrication, cleanrooms, and processes:
 - i. *Lecture*: Microfabrication principles, comparison of technologies, fabrication phases.
 1. Six components of microfabrication – cleaning, deposition, patterning, etching, transfer printing, testing.
 2. Silicon, Other elemental or compound semiconductor, metals, glasses, quartz, sapphire, ceramics, plastics/polymers.
 - ii. *Lab*: Gowning, PPE procedure in the cleanroom. Particle contamination, contamination measurement, cleanroom chemistry and concepts.
 - iii. Substrate fabrication: Si: Poly, single crystal dicing.
 - iv. Provide microfabrication terms to be defined.
 - v. ***HW: Take the “MEMS and cleanroom introduction” section of edX Course and complete all online quizzes.***
 - vi. ***HW: Take the “Lithography” section of edX Course and complete all online quizzes.***

Class 3: September 18th, 2024 (E15-443a)

- b. Patterning
 - vii. HWs will be checked.
 - viii. Work collectively on microfabrication terms given in Class #1.
 - ix. *Lecture*: Lithography, photoresist.
 - x. Provide microfabrication terms to be defined.
 - xi. Work collectively on microfabrication terms given in Class #2.
Lab: Process steps, +/- resist, coating, developing, removing, contact and proximity exposure, projection, alignment and marks, light sources.
 - xii. Provide microfabrication terms to be defined.
 - xiii. ***HW: Take the “Chemical vapor deposition (CVD)” section of edX Course and complete all online quizzes.***
 - xiv. ***HW: Take the “Physical vapor deposition (PVD)” section of edX Course and complete all online quizzes.***

Class 4: September 25th, 2024 (E15-466)

- c. Design parameters and considerations for devices
 - xv. HWs will be checked.
 - xvi. Work collectively on microfabrication terms given in Class #3.
 - xvii. *Lecture*: Device requirements, environmental impact, cost factor.
- d. Deposition
 - xviii. *Lecture*: Thermal oxidation, Physical Vapor deposition (sputtering and E-beam), Chemical vapor deposition (CVD and PECVD), Atomic layer deposition (ALD), Epitaxy (vapor and liquid).
 - xix. Provide microfabrication terms to be defined.
 - xx. ***HW: Take the "Dry etching" section of edX Course and complete all online quizzes.***
 - xxi. ***HW: Take the "Wet etching" section of edX Course and complete all online quizzes.***

Class 5: October 2nd, 2024 (E15-466)

- e. Etching
 - xxii. HWs will be checked.
 - xxiii. Work collectively on microfabrication terms given in Class #4.
 - xxiv. *Lecture*: Wet etch, dry etch.
 - xxv. Provide microfabrication terms to be defined.

Class 6: October 9th, 2024 (E15-443a)

- f. Etching
 - xxvi. Work collectively on microfabrication terms given in Class #5.
 - xxvii. *Lab*: Practicing etching.
 - xxviii. Provide microfabrication terms to be defined.

Class 7: October 16th, 2024 (E15-466)

- g. Transfer printing
 - xxix. Work collectively on microfabrication terms given in Class #6.
 - xxx. *Lecture*: Surface energy, adhesion and release dynamics, delamination velocity and surface energy release rate.
 - xxxi. Provide microfabrication terms to be defined.

Class 8: October 23th, 2024 (E15-443a)

- h. Transfer printing
 - xxxii. Work collectively on microfabrication terms given in Class #7.
 - xxxiii. *Lab*: Students one by one practice transfer printing with automatic, transfer printing tool.
 - xxxiv. Provide microfabrication terms to be defined.
 - xxxv. **HW: Take the “Inspection and metrology” section of edX Course and complete all online quizzes.**

Class 9: October 30th, 2024 (E15-466 & E15-443a)

- i. Packaging and testing
 - xxxvi. HW will be checked.
 - xxxvii. Work collectively on microfabrication terms given in Class #8.
 - xxxviii. *Lecture*: Surface characterization, ACF cabling, electrical characterization/measurements.
 - xxxix. *Lab*: Probe station, microscopy, laser vibrometer.
 - xl. Provide microfabrication terms to be defined.

Class 10: November 6th, 2024 (E15-466)

- j. Internal feedback for the videos
 - xli. *Lecture*: Wrap up.
 - xlii. Defining the problem that is going to be tackled in the next course.
 - xliii. Forming the booklet consists of defined microfabrication terms.
 - xliv. Suggestions for future class.

Class 11: November 13th, 2024 (E15-466)

- k. Internal feedback for the videos
 - xlvi. *Lecture*: Wrap up.
 - xlvi. Defining the problem that is going to be tackled in the next course.
 - xlvii. Forming the booklet consists of defined microfabrication terms.
 - xlviii. Suggestions for future class.

Class 12: November 20th, 2024 (E15-466)

- l. *Lecture*: Final video presentation (internally, to the PI).

Class 13: November 27th, 2024 (E15-466)

- m. *Lecture*: Final video presentation (internally, to the PI).

Class 14: December 4th, 2024 (E15-466)

- n. Video Editing & Publishing
- o. Project
 - xlix. Presentations and demo open to the Media Lab.
 - l. Video contest at Media Lab.

Class 15: December 11th, 2024 (E15-466)

- p. Video Editing & Publishing
- q. Project
 - li. Presentations and demo open to the Media Lab.
 - lii. Video contest at Media Lab.

Calendar

September 2024

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4 First Day of Classes Class 1: Introduction	5	6	7
8	9	10	11 Class 2: Materials Science Background	12	13	14
15	16	17	18 Class 3: Patterning I	19	20	21
22	23	24	25 Class 4: Patterning II	26	27	28
29	30					

October 2024

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2 Class 5: Design I	3	4	5
6	7	8	9 Class 6: Design II	10	11	12
13	14 Indigenous People's Day	15	16 Class 7: Deposition	17	18	19
20	21	22	23 Class 8: Etching	24	25	26
27	28	29	30 Class 9: Packaging and Testing	31		

November 2024

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
	Veterans Day		Class 10: Internal Video Screening I			
17	18	19	20	21	22	23
			Class 11: Internal Video Screening II			
24	25	26	27	28	29	30
			Class 12: Final Video Screening I			
			Class 13: Final Video Screening II	Thanksgiving		

December 2024

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
			Class 14: Video Contest I			
8	9	10	11	12	13	14
			Class 15: Video Contest II (Last Day of Classes)			
15	16	17	18	19	20	21
22	23	24	25	26	27	28
			Christmas Day			
29	30	31				