

**Syllabus (Tentative)**  
**ENS 414/514 - Experimental Methods in Nanoscience 2**  
**Spring 2023-2024**

|                           |   |
|---------------------------|---|
| <b>Instructor</b>         | <i>Ismet I. Kaya</i> , FENS 1024, Phone: 9591   |
| <b>Teaching Assistant</b> | <i>Mehmet Kahraman</i>  |
| <b>Objective</b>          | The objective of this series of courses is to introduce some of the basic experimental methods utilized in nanoscience. The aim is to teach fundamentals of growth, fabrication and characterization of materials and devices in nanoscale. Topics appear to be mostly relevant to physical sciences but can be useful in many multi-disciplinary applications. ENS X14 focuses on characterization techniques relevant to nanoscience. |
| <b>Lecture/Lab Hours</b>  | Thursdays 14:40-17:30 (Considering to change to Thursdays 9:40-12:30 or another time that fits everyone)  |
| <b>Evaluation</b>         | Preliminary works 25%, Lab Reports 40%, Exams 35%,  |
| <b>Attendance policy</b>  | Attendance is required. No make ups will be offered for the experiments. Missing 2 lectures or experiments leads to course failure. In case of an emergency, contact the lecturer as soon as possible.  |

| <b>Topic</b>  | <b>Sub-topics</b>  | <b>Weeks (Lecture + Exp.)</b> |
|---|--|-------------------------------|
| <b>ENS 414/514</b>  |  |                               |
| Microscopy  | Optical microscopes, electron microscopes, scanning probe microscopes                          | 2+2                           |
| Structural characterization of thin films with photons, electrons | Raman, ellipsometry, XRD, LEED, Auger Spectroscopy, EDX  | 1+2                           |
| Electrical characterization                                       | DC and AC measurement techniques to characterize materials and devices                         | 2+2                           |
| Cryogenics  | Generation, transportation and storage of cryogens. Operation principles of various cryostats. | 1+2                           |
| <b>Total</b>  |  | <b>6+8</b>                    |
| <b>ENS 413/513 (Past Semester)</b>                                |  |                               |
| Introduction to the course  |  | 1+0                           |
| Vacuum science and technology                                     | Pumps, gauges, materials, fittings and practical aspects                                       | 1+1                           |
| Lithography   | Optical lithography, e-beam lithography, other techniques                                      | 2+2                           |
| Physical deposition   | Thermal evaporation, E-beam evaporation, Sputtering, PLD, MBE                                  | 1+1                           |
| Chemical deposition   | CVD, PECVD, ALD  | 1+2                           |
| Etching   | Physical and chemical etching, wet etching, RIE, Focused Ion Beam                              | 1+1                           |
| <b>Total</b>  |  | <b>7+7</b>                    |