BE.481 / 7.86 / MAS.866
Fundamental limits of biological measurement

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Units:     3 - 3 - 6

Time:      Tuesdays and Thursdays, 1:00 - 2:30 pm

Location:  56-154

Prerequisites
Senior or graduate level status. Course builds upon foundations in physics, math, and biology.

Goal
To understand physical principles that govern the ultimate limits for measuring force, charge, and optical signals in biological systems.

Grading
50% Problem sets
25% Lab report
15% Presentations
10% Participation

Course website: http://www.media.mit.edu/nanoscale/courses/spring04/index.html
Feb 3 | Course Introduction and Case Study: **DNA Microarrays** (Manalis and Sorger)
Feb 5 | Binding affinity and thermodynamics (Sorger)
Feb 10 | The electrical double layer and electrokinetic transport (Manalis)
Feb 12 | Surface functionality and nucleic acid structure (Manalis and Sorger)
Feb 19 | Applications (student presentations)

**Foundations** *(Parallel tracks)*
Feb 24 | Fourier Analysis (Manalis)..............Building a DNA Microarray (Albeck)
Feb 26 | Corr, Conv, and Filters (Manalis)....Cell biology (Sorger)
March 2 | Nano/microfabrication (Manalis).....Genetics and molecular biology (Sorger)

**Mechanical and Electronic Detection** *(Manalis)*
March 4 | Forces and biological systems (student presentations)
March 9 | Noise, mechanical systems, and ultimate limits of position and force detection
March 11 | Random processes and the fluctuation dissipation theorem
March 16 | Applications of force detection to nuclear magnetic resonance
March 18 | Detecting charge: the single electron transistor

**Optical Sensing and Microscopy** *(Sorger)*
April 1 | Microscopy and biological systems (student presentations)
April 6 | Probes and fluorescence, optical instruments and microscopes
April 8 | Wave theory, spectra, convolution, and optical systems
April 13 | Optical systems from fourier and information theory perspectives

**Diffraction and Imaging** *(Sorger)*
April 15 | Information and biological systems (student presentations)
April 22 | Ultimate limits of optical detection
April 27 | Breaking the limits
April 29 | Xtalography and electron diffraction in biology

**Measurement Laboratory** *(Manalis)*
May 4 | Microcantilever I: thermomechanical properties
May 6 | Microcantilever II: force spectroscopy
May 11 | Optical trap I: calibration
May 13 | Optical trap II: pulling DNA
May 15 | Lab presentations