6.003: Signal Processing

Wrap-Up

- What is 6.003?
- Background on 6.003 revision
- What Comes Next?

18 May 2021

What is 6.003?

What is a signal?

Abstractly, a signal is a function that conveys information

Signal processing is about extracting meaningful information from signals, and/or manipulating information in signals to produce new signals.

What is a transform?

Provide multiple views/perspectives on a signal

Some information more clearly visible (and/or more easily manipulable) from one perspective than another.

Why Fourier?

One reason: Many aspects of physics (and of human perception) are related to frequency representation.

Some things apparent in frequency but not in time (and *vice versa*).

We have efficient ways of computing Fourier transforms.

Fourier methods are broadly used!

Broad Applicability

From Wikipedia:

"Fourier analysis has many scientific applications in physics, partial differential equations, number theory, combinatorics, signal processing, digital image processing, probability theory, statistics, forensics, option pricing, cryptography, numerical analysis, acoustics, oceanography, sonar, optics, diffraction, geometry, protein structure analysis, and other areas."

Why? Among other things:

- FT is an invertible, linear operator
- CE are eigenfunctions of LTI systems
- convolution in time $\rightarrow$ multiplication in frequency
- allows solving differential equations using polynomial algebra
- can be evaluated efficiently on a computer (FFT)

6.003

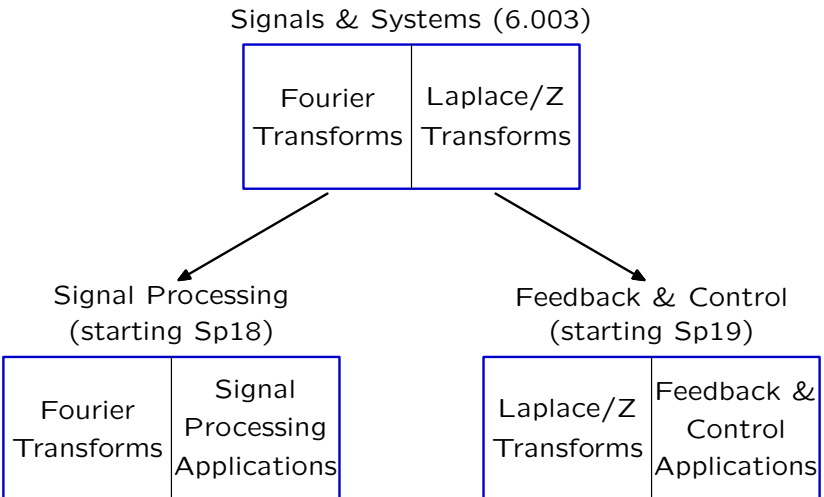
Signals and Systems (6.003) has been a core subject in EECS since 1979 when the four subject (60-unit) core was established.

- 6.001: Structure and Interpretation of Computer Programs
- 6.002: Circuits and Electronics
- 6.003: Signals and Systems
- 6.004: Computation Structures

Many interesting applications were delayed until advanced subjects.

Moving Applications To Foundation Subjects

From "interesting math" to authentic applications.



Goal: integrated applications demonstrate usefulness of theory, but also deepen understanding of that theory.

Changes In Content

Focus on signal processing allows for

- contextualizing theory with applications, and
- exploring areas previously reserved for more advanced subjects

Continuing Coverage:

- Continuous- and Discrete-Time **Fourier Series**
- Continuous- and Discrete-Time **Fourier Transforms**

Added **Discrete Fourier Transform:**

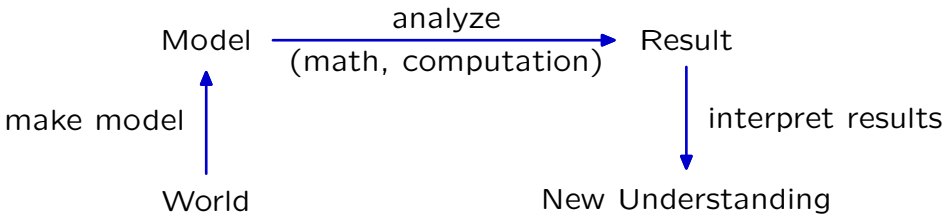
- Facilitates use of computation (what's *actually used* in most applications)
- Close ties to Fourier series and transforms

Added **2D Transforms**

- Very interesting applications, and strongly connected to 1D transforms

Importance of Computation

We are interested in theories that help solve real-world problems.



Classical analyses use a variety of maths, especially calculus. We would also like to use computation which is applicable in many real-world problems that are difficult or impossible to solve analytically.

All three of the arrows above are important!

6.003 Structure is Evolving

Trying to **balance** theory and application effectively is an ongoing process.

Sp18 weekly calendar

- one 90-minute lecture to introduce new material
- one 90-minute individual lab for direct applications
- one 180-minute partnered lab for more open-ended project

Fa18 weekly calendar

- two 60-minute lectures
- two 120-minute problem-solving sessions
- design problems in homework

Sp19 weekly calendar

- two 60-minute lectures
- two 60-minute recitations with worked examples
- two 60-minute scheduled office hours (following recitation)
- design problems in homework with midway checkoffs

Subject Evaluations

Our goal is to present the course material in a way that encourages a deep understanding of the subject matter, while simultaneously being fun and engaging. We need your help and your feedback in order to make that happen.

Send us e-mail, come and talk with us, etc!

Also:

http://registrar.mit.edu/subjectevaluation

What Might Come Next?

- **6.302** Feedback System Design
- **6.011** Signals, Systems, and Inference
- **6.341** Discrete-time Signal Processing
- **21M.387** Fundamentals of Music Processing
- **6.182** Psychoacoustics Project Laboratory
- **6.344** Digital Image Processing
- **6.815** Digital and Computational Photography
- **6.819** Computer Vision
- **6.161** Modern Optics Laboratory
- **6.555** Biomedical Signal and Image Processing
- **6.552** Signal Processing by the Auditory System: Perception
- **6.556** Data Acquisition and Image Reconstruction in MRI
- **18.103** Fourier Analysis
- **18.104** Harmonic Analysis (CI-M)
- **18.065** Matrix Methods in Data Analysis, SP, and ML

Thank You!