This course will introduce you to fundamental concepts needed in order to work with discrete-time signals. The world is continuous, but in order to capture, process, and manipulate signals on a digital computer, we must convert the continuous world into discrete time. The topics we will cover begin with basic mathematical models for discrete-time signals, Fourier analysis, and time-frequency analysis. We will then study discrete-time filters, the Z-transform, and sampling. With time we will cover advanced topics including image processing, wavelets, compressed sensing, and signal representations for machine learning.

Instructor: Professor Laura Balzano, girasole@umich.edu
Course time: Tuesdays and Thursdays, 1:30pm-3:00pm
Course location: 1005 DOW
Instructor Office Hours: Thursdays 3-4pm, Fridays 2:30-3:30pm, EECS 4223
Graduate Student Instructor: Kevin Moon, krmoon@umich.edu
Discussion Session: Wednesdays 12:30-1:30pm, 3150 DOW
GSI Office Hours: Mondays 4-5:30 pm, Location TBD
Pre-requisites: EECS 216 or instructor permission.
http://www.sp4comm.org/getit.html

Grade breakdown:
HW 15%, Exam 1 25%, Exam 2 25%, Project 30%, Feedback and Participation 5%

Exams: There will be two in-class closed-book exams during the semester:
Exam 1 on Thursday, 8 October, in class
Exam 2 on Tuesday, 10 November, in class

Project: There will be a group project that you will work on throughout the semester. The project will be presented on one of the last class days, December 1, 3, 8, or 10. The final website report will be due on the last day of class, Thursday, 10 December.

Homework: Homework will be due every week on Tuesday at the start of class. Late homework will be accepted until Thursday at the start of class with a penalty of 25% per day (any portion of 24 hours). No homework will be accepted beyond that point. The two lowest homework grades will be dropped. No further excuses will be honored.

After a genuine attempt to solve the homework problems by yourself, you are free to collaborate with your fellow students to find solutions to the homework. Regardless of whether you collaborate with other 351 students, you are required to write your own solutions to hand in. Copying homework solutions from another student or from existing solutions will be considered a violation of the honor code.

*AS OF October 21, 2015
**Regrade requests:** Students may request a regrade for exams or homeworks. The regrade request must be submitted in writing within one week of the class period where the professor returned the homework or exam. The entire HW or exam will be regraded, so double check the solutions to make sure that there were not grading mistakes in your favor.

**Project:** The project will be a team project of 2-3 students per team. We'll be collecting data and then using Matlab and our DSP algorithms to analyze the data. The project will be graded on a series of intermediate milestones, a presentation at the end of the semester, and a website due on the last day of class.

**Participation in Lecture and Office Hours:** Active and interactive lectures are the most engaging both for the students and the professor. I would like to know what you don’t understand, so that I can do my best to clarify. Questions during lecture are welcomed and encouraged. My office hours are an informal time to ask questions and learn from one another. They are also a good time for us to get to know each other. Please drop in (the earlier the semester, the better) and share whatever thoughts or questions you have about the course or the material.

**Honor policy:** I take academic integrity very seriously. If I suspect you directly copied work from each other or from some other source, I will report it to the engineering honor council.

Tentatively, we will cover the following topics.

**Introduction (Sept 8-10)**
- Understanding the basic notation
- Signals as sequences
- Discussion: Review of complex exponentials, infinite sum manipulation, Matlab

**Signals and Hilbert Spaces (Sept 15-22)**
- Hilbert Space, inner products
- Subspaces, bases, and projections
- Examples
- Discussion: Practice problems

**Fourier Analysis (September 22-29)**
- DFT, DFS, and DTFT
- Relationships between transforms
- Properties of Fourier transforms
- Duality relationships
- Discussion: Practice problems
Review October 1.
Data Science Launch at Rackham Amphitheater October 6 (no class).
Exam 1 October 8.

Fourier Analysis continued (October 13-15)
- DTFT
- Relationships between transforms
- FFT algorithm and practical considerations
- time-frequency analysis

Filters (October 22-27)
- Discrete linear systems
- impulse response
- lowpass, highpass filters
- FIR and IIR filters
- constant-coefficient difference equations
- Discussion: Practice problems

Z Transform (October 29-November 3)
- Z transform
- Region of Convergence (ROC) and properties
- Z transform properties
- pole-zero plots
- Discussion: Practice problems.


Filter Design (November 12)
- Design specifications and tradeoffs
- Design by windowing
- Minimax design
- Discussion: using filter design tools in Matlab.

Advanced topics (November 17-December 1)
- image processing
- wavelets
- compressed sensing
- signal representations for machine learning
- Discussion: topics relevant for project completion.

In-class project presentations and wrap-up (December 3-10)