EENG 202 S Communications, Computation, and Control

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Syllabus

EENG 202 S is equivalent to EENG 202 taught during the academic year and is a required course for all degrees offered by Electrical Engineering. It is intended for students at Yale during the summer who either want to lighten their required course load during the academic year or learn about electrical engineering.

This course covers topics to prepare students for courses that require EENG 202 as a prerequisite. EENG 202 S teaches topics in the context of the following two engineering design projects implemented in the Matlab programming language.

* *Communications*: Transmitting images from Mars. Four digits from a student’s ID number are transmitted from Mars in the form of 28x28 MNIST images of hand-written digits. Each image is converted to bits and each bit is transmitted from Mars using a signal having a specified energy. The signal received on Earth is corrupted by cosmic noise from the Big Bang. The lectures explore the relationship of the signal-to-noise ratio (SNR) to the error probability obtained by signal detection using template matching. The received image quality is specified, usually nearly pristine images that are easily interpreted. This quality is achieved by both specifying the transmitted signal duration to achieve the required signal energy that gives an acceptable error probability along with an error correction code that improves the final image quality.
* *Control*: Frequency analysis of the motor system response is applied to control the performance of a DC motor system using negative feedback, one of the great ideas in Electrical Engineering. The conditions for implementing a stable feedback control system are determined in the frequency domain.

A major aspect of the course is relating the mathematical and engineering theory to Matlab code. No previous experience in Matlab is assumed, but some previous experience in any programming language is expected. Theory and Matlab code examples are integrated in a lecture format that is called a *live script* file that allows combining theory and corresponding program code with a narrative that explains the function and motivation of the code. The lectures, homework, and projects are live script files.

Lectures:

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| Course topic | Lec | Lecture Topic | Text sections |
| Communications | 1 | Course Overview, Matlab basics. | 16 |
| 2 | Images, Analog-to-digital conversion | 2.5, 7.1 – 7.5 |
| 3 | Forming and detecting data signals. | 10.1 – 10.3 |
| 4 | Detecting data signals in noise. | 10.4 – 10.5 |
| 5 | Simulating a communication system.  | 10.6 |
| 6 | Error correction | 13.1 – 13.3 |
| 7 | Communication project test |  |
| Control | 8 | Moving-Average digital filters. | 8.1 – 8.5 |
| 9 | Autoregressive digital filters. | 8.6 |
| 10 | Discrete Fourier Transform. | 9.1 – 9.4 |
| 11 | Frequency transfer function.  | 9.5  |
| 12 | DC motor speed control | Class notes |
| 13 | Negative feedback | Class notes |
| 14 | Feedback speed control | Class notes |
| 15 | Motor control project test |  |

Course expectations: Students should leave the course with an understanding of how Electrical Engineers solve practical problems. This includes applying mathematical and physical principles; implementing these principles in computer code; recognizing, finding, and correcting bugs; and verifying that the system achieves the desired goal.

Required text: Roman Kuc, *Electrical Engineering in Context*, Cengage Learning, 2015.

Grading:

Class participation 10%

HW 10%

Projects 40%

Tests 40%