6.02
Intro to EECS II
Spring 2008

12 units (2-3-7)

Prereqs: Intro to EECS I (6.01), Physics II (8.02), Differential Equations (18.03) or Linear Algebra (18.06)

• Course mechanics
• Overview of 6.02
Who's who

• Instructors
  - Hari Balakrishnan
  - Vladimir Strojanovic
  - Chris Terman (contact for admin issues)
  - Steve Ward

• TAs
  - Chun-Ming Hsu
  - Doris Lin
  - Ranko Sredojevic
  - Mark Tobenkin

• Staff email: 6.02-staff@mit.edu
A week in the life of 6.02

<table>
<thead>
<tr>
<th>MON</th>
<th>TUE</th>
<th>WED</th>
<th>THU</th>
<th>FRI</th>
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<tbody>
<tr>
<td>Lecture 2-3</td>
<td>Tutorials</td>
<td>Lab 9-12 or 2-5</td>
<td>Tutorials</td>
<td>Lecture 2-3</td>
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<tr>
<td></td>
<td>Office</td>
<td>Pre-lab due</td>
<td></td>
<td>HW out</td>
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<td></td>
<td>hours</td>
<td>Post-lab Interview</td>
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<td>Lab out</td>
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<td>Mini-quiz HW due</td>
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<td>Lecture...</td>
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- **Homework**: most weeks, due on Fridays in lecture
- **Lab**: 3-hour section most Wednesdays, work w/ partner
  - **Pre-lab** due at beginning of lab section
- **TA office hours** Tue/Thu, optional problem-solving groups?
- **Mini-quiz**, ~12 mins most Fridays
Evaluation

- Quiz 1 (15%)
- Quiz 2 (15%)
- Quiz 3 (15%)
- Labs (25%)
- Mini-quiz (20%)
- Homework (10%)
Wireless Communication:
transmitting information from one place to another

First: point-to-point RF link
Then: network of links
Step 1: Grab some spectrum
Step 2: Modulate info onto carrier

Amplitude

Frequency

Phase
Step 3: Deal with errors

Continuous time
Continuous values

Discrete time
Discrete values
Step 4: Thinking about bits

“axabbbllleeewwwaaasssiijeeerrrreee…”

Add redundancy to allow error detection & correction

“ablewas iere isawelba”

Remove redundancy to match data rate with information rate: compression

“110011010100101…”
Step 5: Manipulating bits via logic
Step 6: Network Engineering

Link layer
- channel sharing, circuits vs. packets

Network layer
- best effort packet routing

Transport layer
- reliable end-to-end data stream
6.02 Part I: volt-by-volt

Concepts

- Waveforms in the frequency and time domains: Fourier series
- Modulation/Demodulation, Filtering with difference equations
- I-Q transmission, digital modulation
- Energy and noise

Labs

- Analyze piano notes and chords in the frequency domain
- Receiving frequency division multiplexed (FDM) signals
- Design 16-QAM digital receiver, analyze constellation and eye diagrams
- Experiment with relationship between QAM parameters and error rates
6.02 Part II: bit-by-bit

Concepts

• Error detection and correction for digital channels

• The digital abstraction, logic devices, combinational circuits

• Registers, clocked circuits, arithmetic circuits

• Information entropy, variable-length codes, perceptual coding

Labs

• Add 1-bit error correction to QAM channel (channel coding)

• Design combinational logic to implement ECC above

• Design logic that implements a FIR low-pass filter

• Develop Huffman code for run-length encoding of images
6.02 Part III: packet-by-packet

Concepts

• Sharing a communications channel

• Packet-switched multi-hop networks, shortest-path routing

• Reliable transport on top of best efforts network layer

Labs

• Aloha channel access

• Implement adaptive shortest-path routing algorithm on net simulator

• Implement a reliable transport protocol in the presence of lossy communication links.
Our experimental apparatus

- Analog Headset
- PC w/ sound card
- Matlab
- Universal Software Radio Peripheral (USRP board)

USB cable
The USRP board
Point-to-Point Communication: transmitting information from one place to another

Transducer: sound to voltage/current

Signal Processing → Source Encoding → Channel Encoding → Modulation

Transducer: voltage/current to sound

Signal Processing → Source Decoding → Channel Decoding → Demodulation
Point-to-Point Communication:
transmitting information from one place to another

- **USB Headset**
- **Sound Card**
- **USRP Card**

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<tr>
<th>Signal Processing</th>
<th>Source Encoding</th>
<th>Channel Encoding</th>
<th>Modulation</th>
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<tr>
<td><strong>PC running Matlab</strong> (processing vectors of numeric samples)</td>
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An integrated, hands-on introduction to electrical engineering and computer science. Lectures and laboratory experiments explore

- modeling transmission systems in time and frequency domains,
- analog and digital signaling,
- channel and source coding,
- the digital abstraction and logic devices,
- the engineering of packet-switched networks.

These explorations are used to illustrate some common EECS themes:

- the role of abstraction and modularity in engineering design,
- building reliable systems using imperfect components,
- selecting appropriate design metrics,
- understanding the limits imposed by energy and noise,
- choosing effective representations for information,
- analyzing the performance and correctness of algorithms,
- engineering tradeoffs in complex systems.