Course Admin

EL-GY 6013: DIGITAL COMMUNICATIONS

PROF. SUNDEEP RANGAN

People and Time

- Professor: Sundeep Rangan, srangan@nyu.edu
  - 2 MetroTech Center 9.104
  - Office Hours: Thursdays, 2-4pm

- TA:
  - Sourjya Dutta, sdutta@nyu.edu
  - Office Hours: TBD
  - Ask for all questions regarding homeworks and labs

- Location: JAB 673
  - Tuesdays, 12:30 to 3pm

Pre-requisites

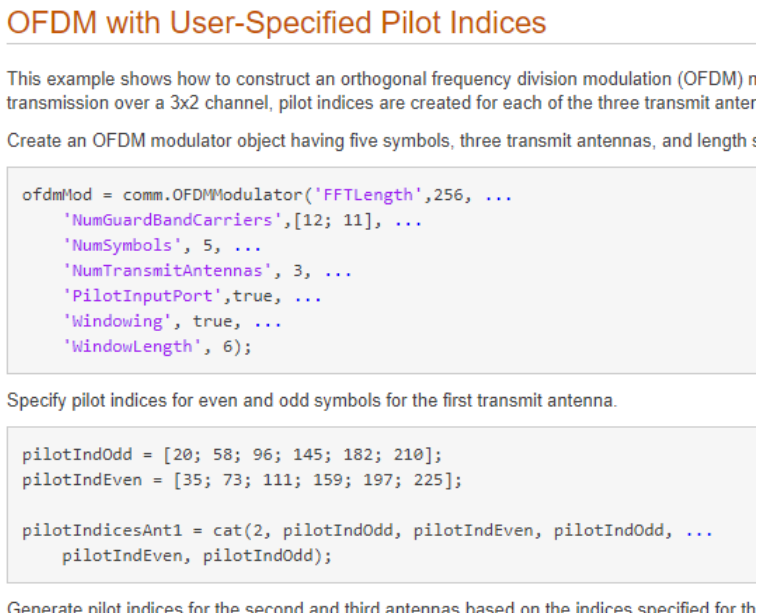
- EL6303 Graduate probability
  - This is essential
  - Chapters 1-7 and chapter 9 from Papoullis, Pillai
  - This class is offered this semester

- Undergraduate signals & systems:
  - Fourier transforms, filters, sampling, bandwidth

- We will review stochastic processes only very briefly.

MATLAB

- All labs will be in MATLAB
- Download the latest MATLAB with Communications Toolbox
- NYU students can get this for free:
  - https://www.mathworks.com/academia/tah-portal/new-york-univers
  - Make sure you get R2018B (Latest version)
- Communications Toolbox
  - Very powerful set of tools for simulating communications systems
  - Building blocks for all common parts
  - Channels, modulators, demod, coding, decoding, …
  - Can integrate with Simulink
  - Can even export to HDL for synthesis



OFDM with User-Specified Pilot Indices

This example shows how to construct an orthogonal frequency division modulation (OFDM) n
transmission over a 3x2 channel, pilot indices are created for each of the three transmit anter

Create an OFDM modulator object having five symbols, three transmit antennas, and length s

```
ofdmMod = comm.OFDMModulator('FFTLength',256, ...
    'NumGuardBandCarriers',[12; 11], ...
    'NumSymbols', 5, ...
    'NumTransmitAntennas', 3, ...
    'PilotInputPort',true, ...
    'Windowing', true, ...
    'WindowLength', 6);
```

Specify pilot indices for even and odd symbols for the first transmit antenna.

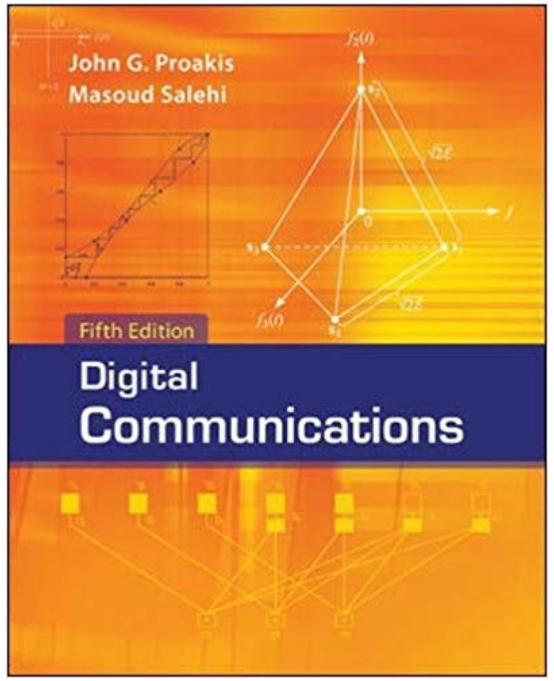
```
pilotIndOdd = [20; 58; 96; 145; 182; 210];
pilotIndEven = [35; 73; 111; 159; 197; 225];

pilotIndicesAnt1 = cat(2, pilotIndOdd, pilotIndEven, pilotIndOdd, ...
    pilotIndEven, pilotIndOdd);
```

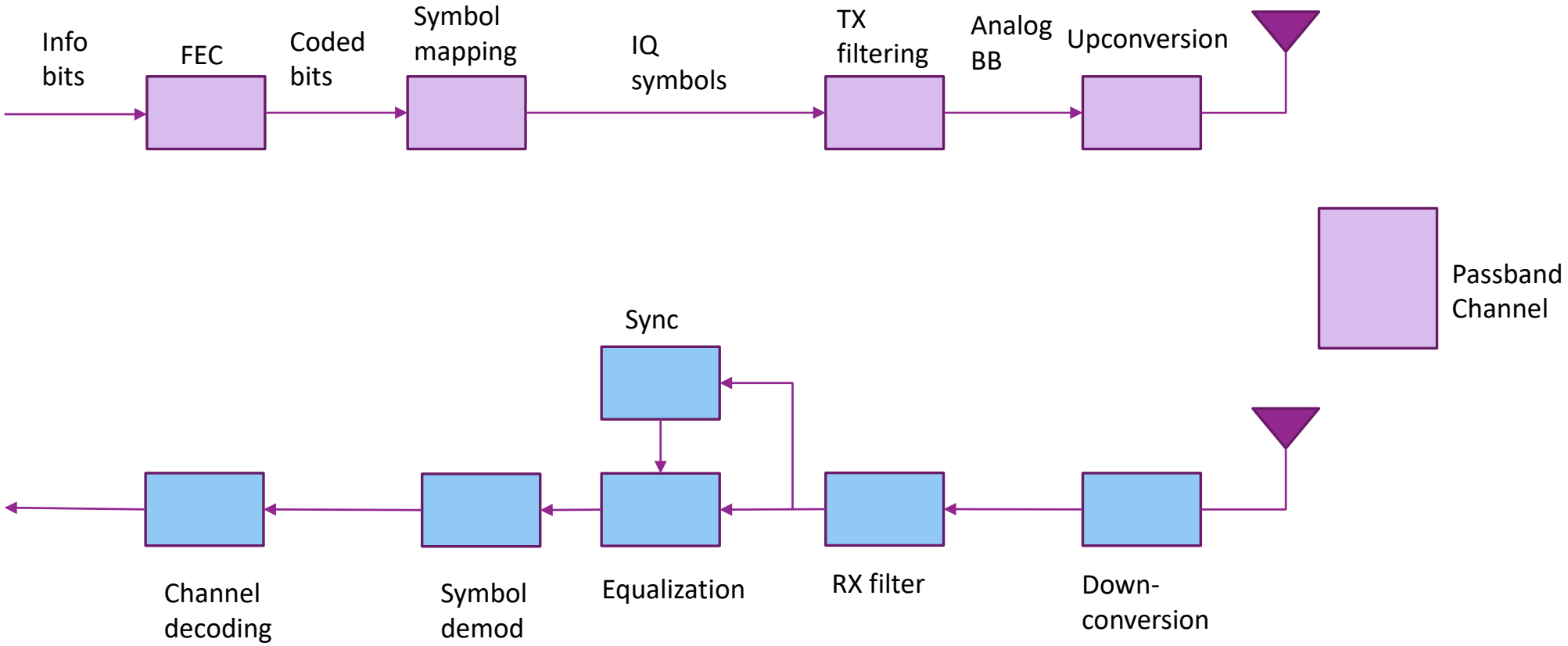
Generate pilot indices for the second and third antennas based on the indices specified for th

Text

- Proakis, Salehi, “Digital Communications”
  - Fifth edition
- Good points:
  - Very comprehensive. Widely-used
  - Lots of problems
- But, extremely abstract
  - I will try to make it more concrete
- It is OK if you have an older version
  - TA will post the questions when we use problems from the book



Class will Follow this Block Diagram



Tentative Schedule

Lecture	Date	Topic	Text section
1	1/29/2019	Introduction. Passband modulation	Proakis 2.1
2	2/5/2019	Stochastic models for signals	Proakis 2,6, 2.7
3	2/12/2019	TX and RX filtering	Proakis 3.4
4	2/19/2019	Symbol mapping, signal space theory	Proakis 3.2, Proakis 2.2
5	2/26/2019	Synchronization, match filtering and noise	Proakis 4.5, 5.1-5.3
6	3/5/2019	Symbol demodulation	Proakis 4.1-4.3
7	3/12/2019	Midterm review	
8	3/19/2019	Spring break, no class	
9	3/26/2019	Midterm	
10	4/2/2019	Equalization	Proakis 9.1,9.3
11	4/9/2019	Linear codes	Proakis 7
12	4/16/2019	Convolutional and turbo codes	Proakis 8
13	4/23/2019	Information theory	Proakis 6
14	4/30/2019	Final review	
15	5/7/2019	Final exam	

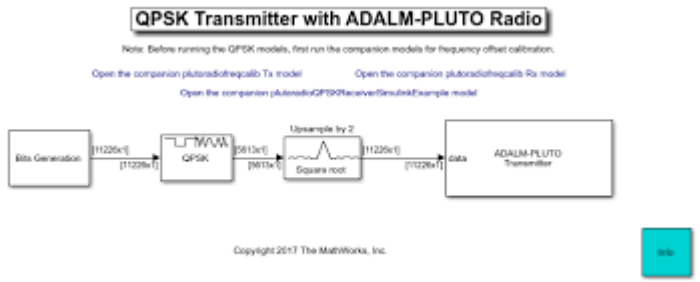
- Note: March 5 class will need to be moved or taught by a guest lecturer

Grading

- Grading:
  - 30% homework, labs and quizzes, 35% midterm, 35% final
- Quizzes:
  - One problem asked at end of each class.
  - Based on previous lecture
- Exams: Midterm and final are closed book, 2 cheat sheets.
  - No calculators
- Optional project:
  - Can replace up to 20% of your grade

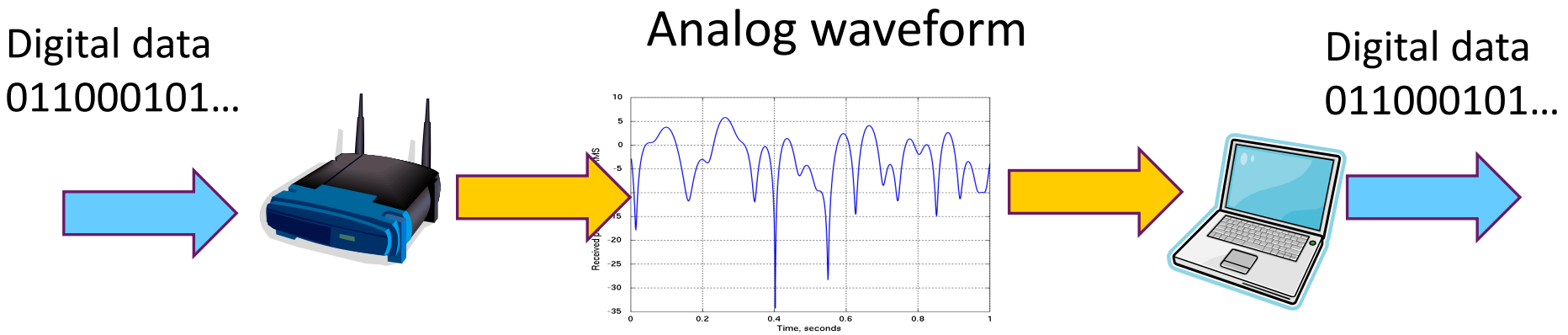
Optional Project

- Can replace up to 20% of your grade
- Should be significant work beyond the class
  - Some advanced topic
  - New research idea
- Should include some detailed simulation
- Bonus for hardware implementation
  - One idea: Use the ADAM Pluto board

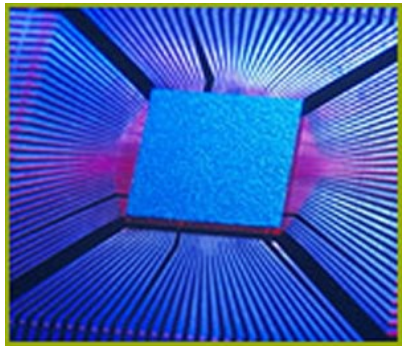


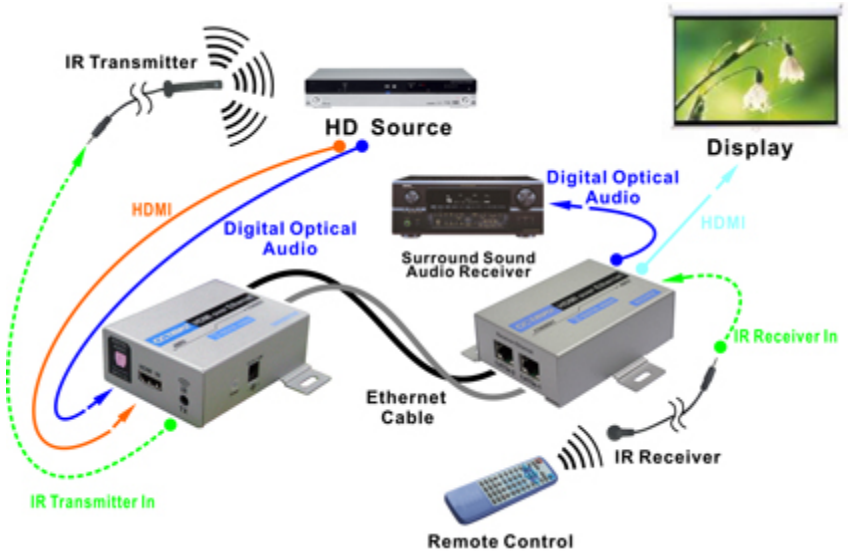
What is Digital Communications?

- Transmission of digital data through a channel



Digital Communications is Everywhere!





- Many scales, data rates, channel media, ranges, …

What do Communications Theorists Do?

- Try to make communication:
  - Reliable,
  - Fast,
  - Cheap, …

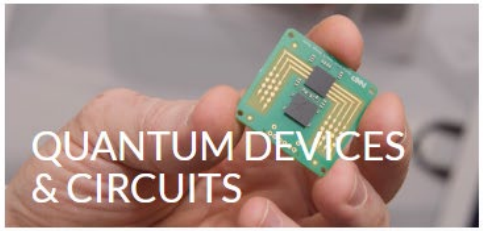
- Basic tools in this class:
  - Look at point-to-point links.
  - Model transmission and reception as a statistical estimation problem.
  - Develop mathematical methods for good communication

Research at NYU WIRELESS

RESEARCH | TERAHERTZ, 5G & BEYOND

Researchers at NYU WIRELESS are at the forefront of beyond 5G technologies, 6G Terahertz networks and devices, software defined networks, quantum sensors and nano devices, position location, and massive broadband applications built on Machine Learning.

Our current research focus areas are:



Course Learning Objectives

- ❑ Mathematically describe the components of a basic communication link
  - Mixing, filtering, symbol modulation, synchronization, equalization, channel coding, …
- ❑ Simulate the system
- ❑ Mathematical analyze the performance of the system
  - Model impairments in the channel and devices
  - Measure the performance such as bit error rate, power, …
- ❑ Optimize the parameters of the design to maximize various performance metric
  - Account for constraints such as power, complexity, …