Welcome to CMSC/MATH/ENEE 456: Cryptography

August 31, 2020
Today: Admin, Intro to Crypto, Shift Cipher

August 31, 2020
BILL, RECORD LECTURE!!!!

BILL RECORD LECTURE!!!!
Admin

August 31, 2020
Necessary Administrative

Course Webpage:
Necessary Administrative

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Course Zoom Site:
https://umd.zoom.us/my/gasarch
Necessary administrative stuff

- Gradescope: you will **post HW** there.
- Gradescope: we will **grade HW** there.
- Regrade Requests due within a week of the HW being graded.
- Grades on Elms.
- Piazza is great for asking questions.
TAs

- Yuang Shen (he goes by Eric)
- Zan Xu
- Josh Twitty
- Their office hours and mine (on Zoom) are on policy part of website.
- Their emails and mine are on policy part of website.
What You Need For This Class

- Discrete math, probability, modular arithmetic, algorithms, misc math.
- Mathematical maturity.
- Ability to write short to middle-sized programs. (This is not a course like Operating systems where the project is a large part of the course intellectually and for the grade.)
How to Get the Most Out of This Class

1. Read notes and slides before class. (Caution Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain false information.)

2. Ask questions on Piazza and/or bring questions to class.

3. This course will be taped so can catch up or review. Caution
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   3.1 If cut class and DO watch videos in sync, fine.
   3.2 If cut class and INTEND to watch videos in sync, not fine.
   3.3 Tape might not always work.
HWs/exams

- HWs most weeks.

Due Monday before class begins. But see next item.

Dead Cat Policy: Can submit HW Wed before class without penalty.

WARNING: YOU have already been given an extension, HW solutions will be posted on Wed, so NO extensions past that.

We will keep track of your lateness NOT for grade, but for recommendation letters.
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Textbook

**Required Text** None.

**Recommended Text** None.
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**Recommended Text** None.

There will be notes, slides, and recordings of lecture online.
How to contact Prof or TAs

▶ email: Please put “456” in subject line.

▶ Office hours

▶ Piazza

▶ We are around A LOT outside of office hours. Its not as though we’re going anywhere!
Intro To Cryptography

August 31, 2020
Crypto Is...

- Crypto is amazing.
  - Can do things that initially seem impossible. Example: Alice and Bob can establish a secret key without meeting.

- Crypto is important. Example: Secure financial transactions.
  - It impacts us every day Example: The last time you used a credit card you used crypto.

- Crypto is fun! Example: Making and breaking codes!
Crypto Is Not...

James Bond is fictional.

James Bond is a drunk.

See article on course website: License to Swill.

James Bond's Villains are stupid.

See video on course website Goodbye Mr. Bond.

Seriously: Spying depends a lot more on Math than on Fancy Tuxedos.
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Classical VS Modern Cryptography

**Classical:** (1900 BC?–1975)

2. WWII: They used people good at crossword puzzles (see course website for an article on this).
3. Turing and others brought math into it, but not much math compared to Modern.

**Modern:** (1976–today)

1. Lots of Math. Lots of Rigor.
2. The notion of Provably Secure important.

Note: The cutoff of 1975–1976 is approximate since History of Crypto is hard and sometimes secret.
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We Begin With Classical Cryptography

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- Shows why unprincipled approaches are dangerous (unprincipled means \textbf{not-rigorous}, not \textbf{immoral}).
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▶ Illustrates why things are more difficult than they may appear.
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▶ Illustrates why things are more difficult than they may appear.

▶ Simple examples of what will later be advanced concepts.
The Course’s Main Scenario

August 31, 2020
Alice, Bob, and Eve

Alice sends a message to Bob in code. Eve overhears it. Alice and Bob want Eve to not be able to decode it. This can mean one of two things:

- Eve does not have enough information to decode it. So even if Eve had unlimited computing power she could not decode. This is Information-Theoretic Security.
- Assuming Eve can't factor quickly (or some other computational limitation) then Eve cannot break the code. This is Computational Security.
Alice, Bob, and Eve

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The First Step in Any Cipher: Spaces

Alice wants to encode:

Cryptography is an important part of security
The First Step in Any Cipher: Spaces

Alice wants to encode:

Cryptography is an important part of security
She uses SHIFT-BY-1 to get:
The First Step in Any Cipher: Spaces

Alice wants to encode:

**Cryptography is an important part of security**

She uses SHIFT-BY-1 to get:

**Dsquizphsbizjtbojnqpsbibouqbsupgtfdvszjuz**
The First Step in Any Cipher: Spaces

Alice wants to encode:

**Cryptography is an important part of security**

She uses SHIFT-BY-1 to get:

**Dszquphsbiz jt bo jnqpsubou qbsu pg tfdvsjuz**

Without any fancy math Eve knows that the second and third word are two letters long. That's information she can use!
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Alice needs to hide spacing information. What to do?
Alice wants to encode
The First Step in Any Cipher-Blocks of Five

Alice wants to encode

**Cryptography is an important part of security**
Alice wants to encode

Cryptography is an important part of security

She breaks the message into blocks of 5:

Cryptography is an important part of security

and then codes it.
The First Step in Any Cipher-Blocks of Five

Alice wants to encode

**Cryptography is an important part of security**

She break the message into blocks of 5:

**Cryto graph yisan impor tantp artof secur ity**

and then codes it.

Because of blocks-of-5, spaces will not give anything away.
The First Step in Any Cipher-Other Issues

I want to encode:

Are my TAs for CMSC/MATH/ENEE 456 awesome? YES!
The First Step in Any Cipher—Other Issues

I want to encode:

\[ \text{Are my TAs for CMSC/MATH/ENEE 456 awesome? YES!} \]

1. Capital and small letters leak information.
The First Step in Any Cipher—Other Issues

I want to encode:

Are my TAs for CMSC/MATH/ENEE 456 awesome? YES!

1. Capital and small letters leak information.
   Map everything to Capitals.
The First Step in Any Cipher—Other Issues

I want to encode:

Are my TAs for CMSC/MATH/ENEE 456 awesome? YES!

2. Punctuation leaks information.
The First Step in Any Cipher-Other Issues

I want to encode:

Are my TAs for CMSC/MATH/ENEE 456 awesome? YES!

2. Punctuation leaks information. Get rid of all punctuation.
The First Step in Any Cipher-Other Issues

I want to encode:

Are my TAs for CMSC/MATH/ENEE 456 awesome? YES!

1. Capital and small letters leak information. 
   Map everything to Capitals.
2. Punctuation leaks information. 
   Get rid of all punctuation.
3. What to do about numbers?
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3. What to do about numbers?  
   Just like letters- alphabet is 36 characters.
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   Just like letters- alphabet is 36 characters.  
   More generally, we will take into account alphabet size.
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Note: We assume $a, \ldots, z$ unless otherwise noted.
BILL, TURN OFF RECORDING

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