BILL, RECORD LECTURE!!!
What Have We Learned From Classical Ciphers?
General Principles

1. English, other languages, finance data, whatever all have patterns that can be used to help crack codes.

2. Kerchoffs’s Principle
   Eve knows the coding system that Alice and Bob are using. More generally, Alice and Bob should use a system whose security does not depend on Eve not knowing the system.

   Caveat
   It may be that when Alice and Bob first use a system Eve does not know what is is, which makes it more secure temporarily.

3. This course is mostly on the mathematics part of crypto. Some students have said correctly What is we use Vig and then Matrix? Won’t that be more secure? The answer is Yes and people do do things like that; however, this course won’t deal with this. Also, see next point.

4. If Eve does not know you are doing this double-encoding, then does add an extra layer of security. But by Kerchoffs’s principle, Eve will know. But see next point.

5. Double encoding will make Eve take more time to crack which is a mild win.

6. Someone in Class Noted this Aside from 1-time pad, NO code is UNCRACKABLE. So our job is to make it take so long to crack that by the time Eve decodes it does not matter.
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2. Key Space Principle A large keyspace is a necc. condition to make a code uncrackable.

3. Crackability depends both on math and on technology. Affine was once hard to crack but is now easy to crack.

4. Ease of Use Its not enough for a system to be hard to crack. It must also be easy to use. That is why the quadratic cipher was never used, even 2000 years ago when it would have been harder to crack than affine.

Mini Project Actually code up and crack shift, affine, quadratic, and see what the gap is in the IS-ENGLISH program.
The Shift, Affine, Quad Ciphers

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Gen Sub Cipher

1. Just saying

2. Frequency Analysis is not enough to crack it.


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5. Cryptography is really used. Any field that is really used has to have a combination of mathematics, empirical, and even ad-hoc guesswork.

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   Old Way: Spotting a pattern that occurred many times used to be done by humans and required practice.
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1-Time Pad, Keyword Shift, Linear Cong Gen

1. 1-Time Pad
   - Uncrackable but needs truly random bits.

2. Want: from a small source of perhaps random bits, generated a longer string of pseudo-random bits.

3. Keyword Shift cipher is one example of trying to generate a random looking sequence of bits. It also has a shorter key than gen-sub-cipher. It is no longer used since it's just a gen-sub-cipher so crackable anyway.

4. Mini Project
   - Code up Keyword Shift cipher and see if it's easier to crack than the Gen Sub Cipher.

5. Linear Cong Gen
   - Used but crackable. Eve needs to know about the topic, which she does.

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   - Code it up. Better with longer or shorter words to look for?

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Gen 2-Sub Cipher and Matrix

1. Gen 2-Sub Cipher
   Timing is everything: There was never a time this was easy to use and hard to crack.
   
   Mini Project
   Write a program to crack Gen 2-sub cipher.

2. Matrix Cipher
   Cipher-text only might be uncrackable, but see next item.
   
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   Write a program to crack matrix cipher-text only.

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   If Eve has pairs of plaintext-cipher text then she can easily crack the Matrix cipher. This makes us realize that we need to be careful on what we can assume Eve knows.
   
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   Write a program to crack matrix cipher given pairs. Requires you to write programs that deal with matrices mod 26. There are many Matrix Packages on the web and in Python, but they are for matrices over $\mathbb{Q}$ and cannot be adapted for mod 26.
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We want that if NY appears many times in the text then it is coded different ways.

2. If do this deterministically then need a long key.

3. The only way to do this with a short key is to use randomization.

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