EXPERIMENT NUMBER 6

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Title: Hashing - one-way randomness in hash-function.

Aim: Study, understand and demonstrate hash function and its tool

Objective: To make students understand and demonstrate hash function and security benefit of hashing in encryption-decryption

Theory:

1. **Hash function:** A function that maps a message of any length into a fixed-length hash value, which serves as the authenticator
2. A variation on the message authentication code is the one-way hash function.
3. As with the message authentication code, a hash function accepts a variable-size message *M* as input and produces a fixed size output, referred to as a **hash code** H(*M*).
4. Unlike a MAC, a hash code does not use a key but is a function only of the input message.
5. The hash code is also referred to as a **message digest** or **hash value**.
6. The hash code is a function of all the bits of the message and provides an error-detection capability: A change to any bit or bits in the message results in a change to the hash code.

Simple Hash Function – Type I

1. All hash functions operate using the following general principles.
2. The input (message, file, etc.) is viewed as a sequence of *n*-bit blocks. The input is processed one block at a time in an iterative fashion to produce an *n*-bit hash function.
3. One of the simplest hash functions is every block's bit-by-bit exclusive-OR (XOR).
4. This operation produces a simple parity for each bit position, known as a longitudinal redundancy check.

$$C_i = b_{i1} \oplus b_{i1} \oplus \ldots \oplus b_{im}$$

where

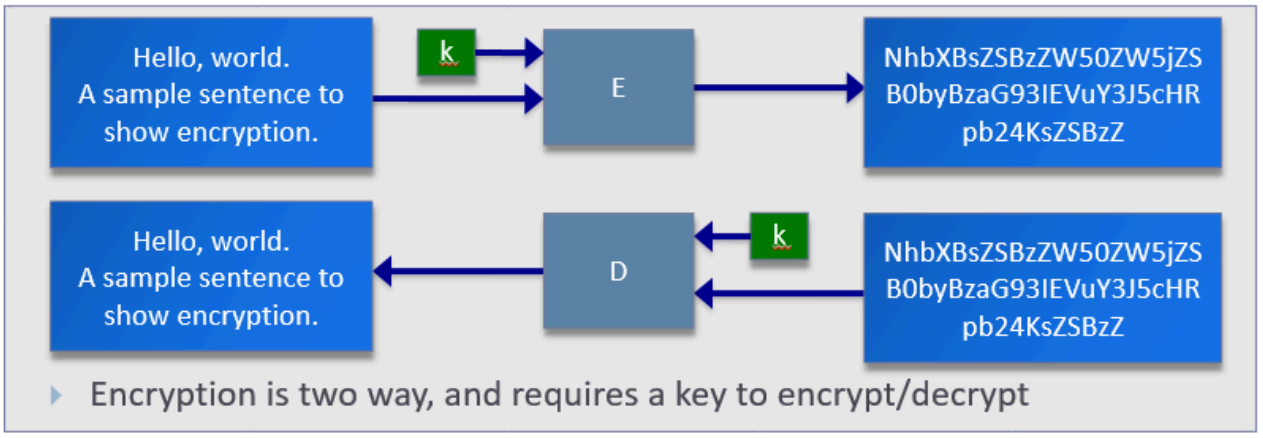
C_i = ith bit of the hash code, $1 \leq i \leq n$

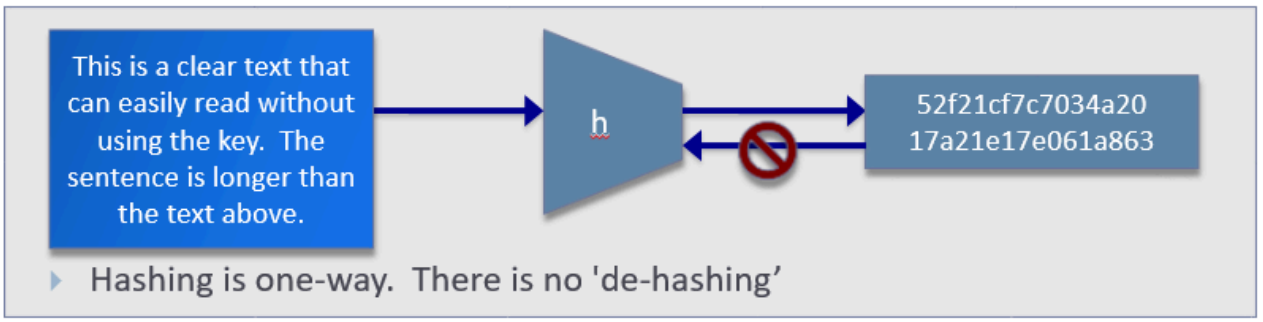
m = number of n-bit blocks in the input

b_{ij} = ith bit in jth block

$\oplus$ = XOR operation

Hashing V.S. Encryption





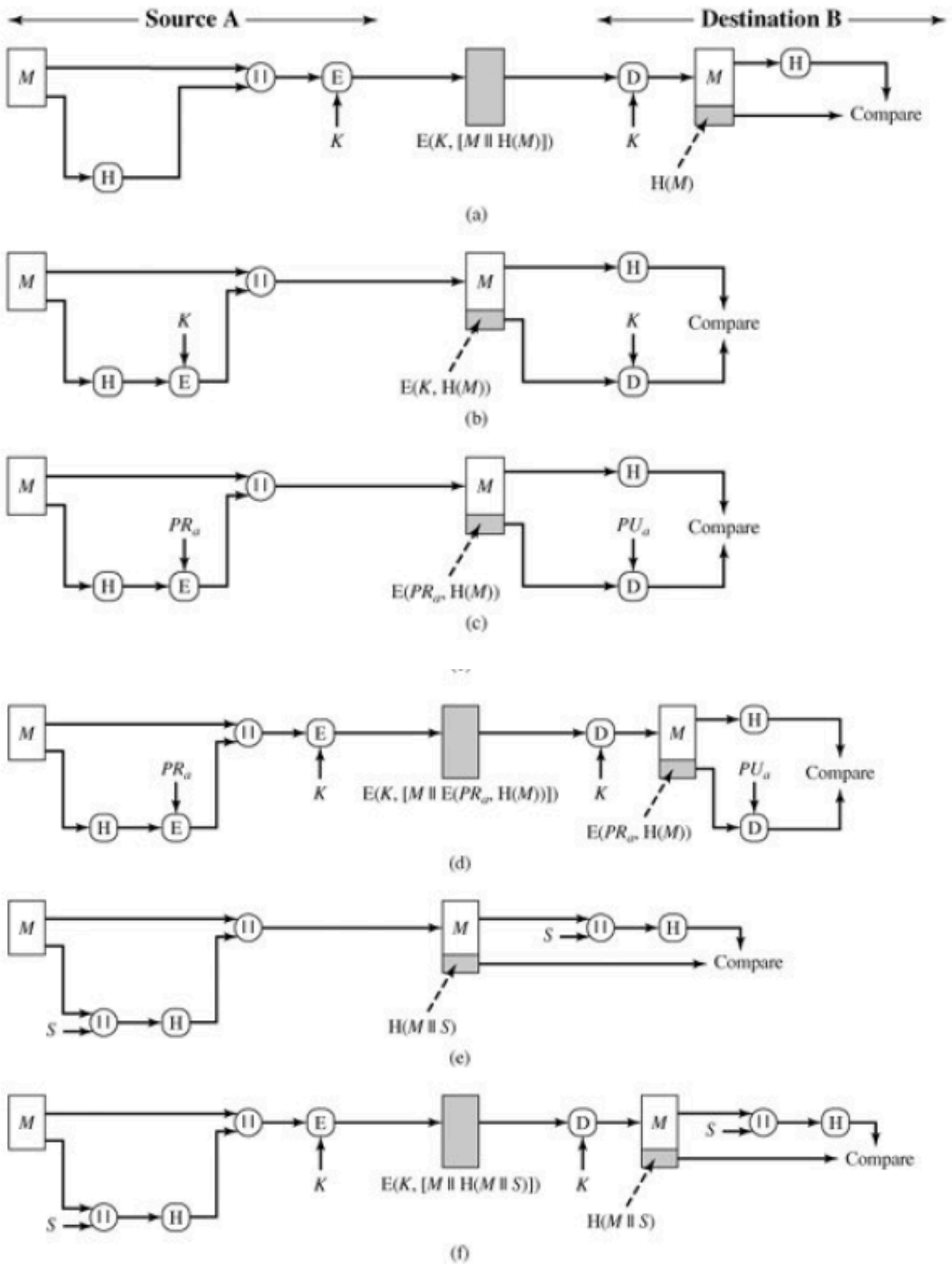


Figure: Basic Uses of Hash Function

[Source: Cryptography and Network Security: Principles and Practice by William Stallings]

Tools to be practiced:

1) Assignment from Cryptography Virtual Lab (website link 1)
2) HashCalc
3) MD6 Hash Generator
4) All Hash Generator
5) HashMyFiles
6) Some mobile hash calculation tools

Reference web links:

1) https://cse29-iiith.vlabs.ac.in/
2) https://www.nirsoft.net
3) https://convert-tool.com
4) https://www.slavasoft.com
5) https://onlinehashtools.com
6) https://www.devglan.com/cryptotools/cryptography-tools
7) https://www.browserling.com

Conclusion:

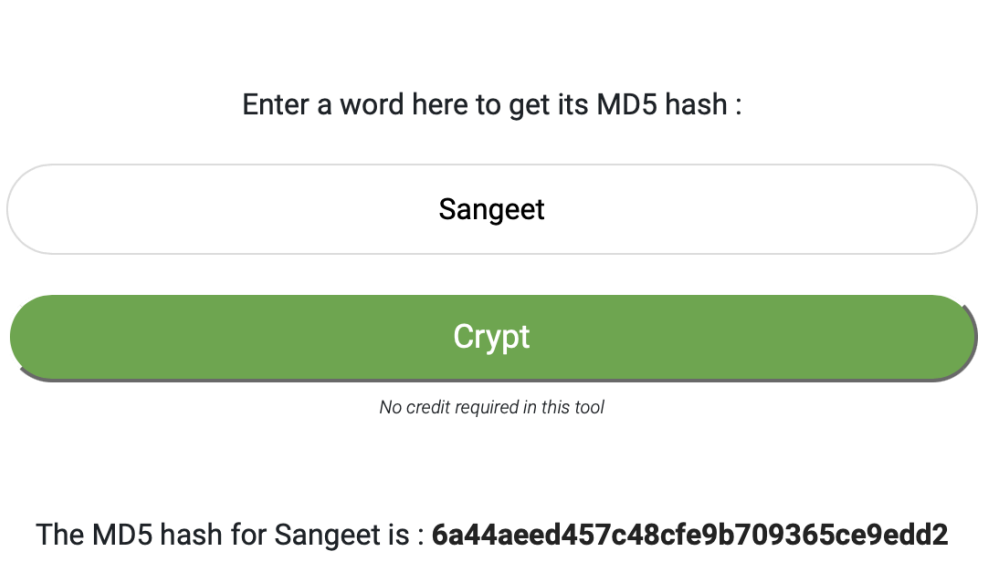
Implementation question:

1) Demonstrate any other two free cryptography tools based on hash function
2) Perform 1 assignments from virtual lab based on hash function
3) Study and differentiate between MD5 and Hash.

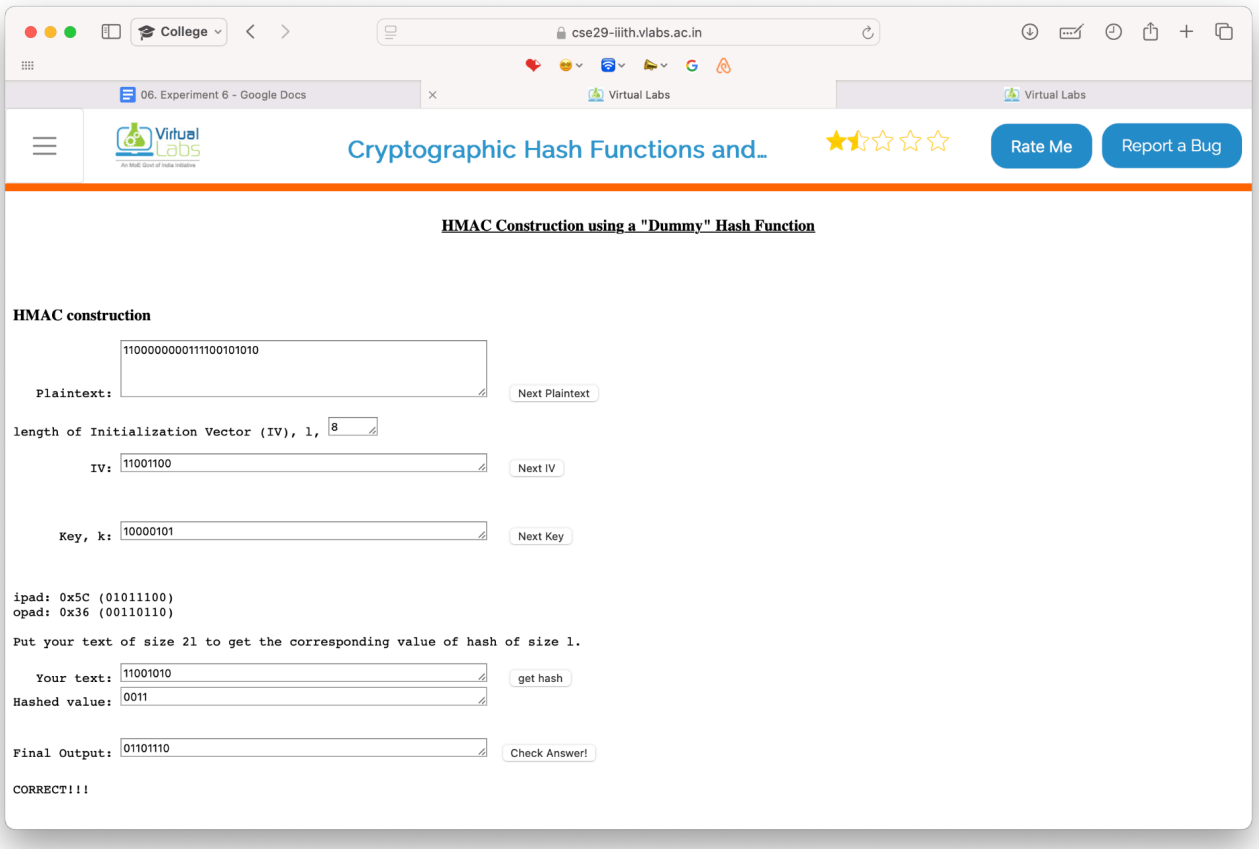
Note: Students are suggested to use Linux OS based tools or free Windows OS based tools.

1) MD4 Hash: http://www.practicalcryptography.com/hashes/md4-hash/

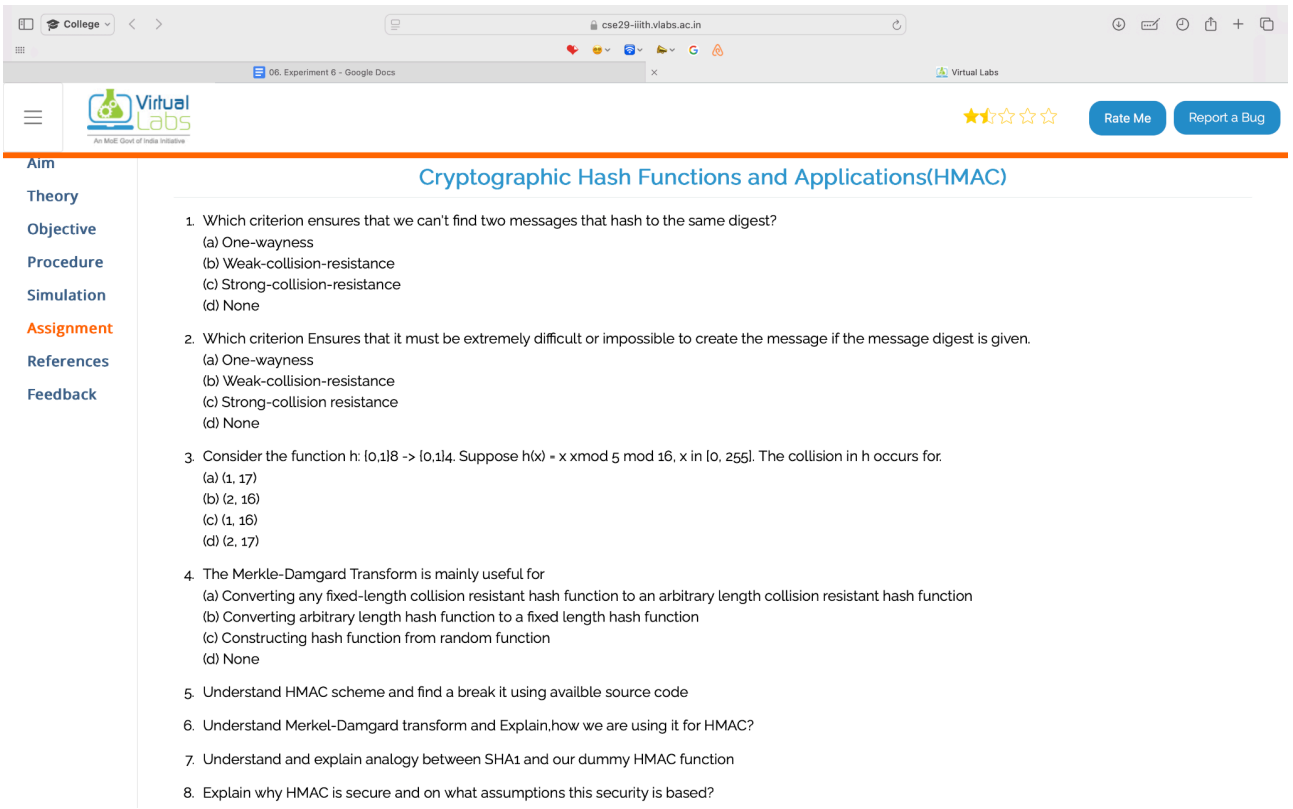
MD5 Hash: https://www.md5online.org/md5-encrypt.html



2) Simulation:



Assignment:



Answers:

1. (c) Strong-collision-resistance
2. (a) One-wayness
3. (c) (1, 16)
4. (a) Converting any fixed-length collision-resistant hash function to an arbitrary-length collision-resistant hash function
5. **Breaking HMAC:** HMAC relies on a secure hash function; breaking it is difficult unless the hash function is weak.
6. **Merkle-Damgård in HMAC:** Used to extend fixed-length hash functions to variable-length inputs, ensuring efficient hashing in HMAC.
7. **SHA-1 and Dummy HMAC Analogy:** Both involve hashing in multiple rounds with compression functions and padding.
8. **HMAC Security:** Secure due to the use of a secret key and a collision-resistant hash function. Security assumes the hash function is strong and the key is secret.

3) Differentiating between MD5 and Hash:

Features	MD5	General Hash Function
Output Size	128-bit	Varies (e.g., 256-bit for SHA-256)
Speed	Fast	Varies by algorithm
Security	Vulnerable to collision attacks	Depends on algorithm (e.g., SHA-256 is secure)
Use Cases	Checksums, file integrity (non-critical)	Cryptography, digital signatures, data integrity
Current Relevance	Considered insecure	Modern algorithms (like SHA-256) are secure and widely used