# CS 7349
# Data and Network Security
# Quiz #4

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Due: Feb 19 2024

Cryptography and Network Security: Principles and Practice, 6th Edition, by William Stallings

### CHAPTER 6: BLOCK CIPHER OPERATION

## TRUE OR FALSE

1. Once the plaintext is converted to ciphertext using the encryption algorithm the plaintext is then used as input and the algorithm is applied again.

   **Solution:** False.

   **Explanation:** The encryption algorithm converts plaintext to ciphertext in one step; the plaintext is not used as input again for the same encryption process.

2. There are no practical cryptanalytic attacks on 3DES.

   **Solution:** False.

   **Explanation:** While 3DES is significantly more secure than DES, theoretical cryptanalytic attacks exist, though they are not considered practical due to their high computational cost.

3. A mode of operation is a technique for enhancing the effect of a cryptographic algorithm or adapting the algorithm for an application.

   **Solution:** True.

   **Explanation:** Modes of operation are indeed techniques for enhancing the security of cryptographic algorithms and adapting them for various applications, such as encryption of streams or blocks of data.

4. The XTS-AES standard describes a method of decryption for data stored in sector-based devices where the threat model includes possible access to stored data by the adversary.

   **Solution:** True.

   **Explanation:** XTS-AES is designed for encrypting disk sectors and is particularly suited to scenarios where adversaries might gain access to stored data.

5. S-AES is the most widely used multiple encryption scheme.

   **Solution:** False.

   **Explanation:** S-AES (Simplified AES) is used for educational purposes and is not the most widely used encryption scheme. AES (Advanced Encryption Standard) is the most widely used scheme.

6. Given the potential vulnerability of DES to a brute-force attack, an alternative has been found.

   **Solution:** True.

   **Explanation:** Given DES's vulnerability to brute-force attacks, alternatives such as AES and 3DES have been developed and widely adopted.

7. A number of Internet based applications have adopted two-key 3DES, including PGP and S/MIME.

   **Solution:** True.

   **Explanation:** Two-key 3DES has been adopted by various Internet-based applications, including PGP and S/MIME, due to its balance between security and performance.

8. The sender is the only one who needs to know an initialization vector.

   **Solution:** False.

   **Explanation:** Both the sender and receiver need to know the initialization vector (IV) for proper encryption and decryption. The IV does not need to be kept secret like the key, but it should be unique and unpredictable for each session.

9. A typical application of Output Feedback mode is stream oriented transmission over noisy channel, such as satellite communication.

   **Solution:** True.

   **Explanation:** Output Feedback (OFB) mode is suitable for stream-oriented transmissions over noisy channels because it turns a block cipher into a stream cipher, making it more resilient to errors in transmission.

10. Cipher Feedback (CFB) is used for the secure transmission of single values.

    **Solution:** True.

    **Explanation:** Cipher Feedback (CFB) mode can be used for encrypting single values by treating the cipher as a stream cipher, allowing for the encryption of data units smaller than the block size.

11. Cipher Block Chaining is a simple way to satisfy the security deficiencies of ECB.

    **Solution:** True.

    **Explanation:** Cipher Block Chaining (CBC) mode addresses some of the security deficiencies of Electronic Codebook (ECB) mode, such as patterns in plaintext not resulting in patterns in the ciphertext.

12. It is possible to convert a block cipher into a stream cipher using cipher feedback, output feedback and counter modes.

    **Solution:** True.

    **Explanation:** Block ciphers can be converted into stream ciphers using modes like Cipher Feedback (CFB), Output Feedback (OFB), and Counter (CTR) modes, allowing them to encrypt data in a stream-like fashion.

13. Cipher Feedback Mode conforms to the typical construction of a stream cipher.

    **Solution:** True.

    **Explanation:** Cipher Feedback Mode (CFB) indeed behaves like a stream cipher, making it suitable for environments where block alignment is not convenient.

14. OFB mode requires an initialization vector that must be unique to each execution of the encryption operation.

    **Solution:** True.

    **Explanation:** OFB mode requires a unique initialization vector for each encryption operation to ensure security and prevent replay attacks.

15. The XTS-AES mode is based on the concept of a tweakable block cipher.

    **Solution:** True.

    **Explanation:** XTS-AES mode is based on the concept of a tweakable block cipher, which allows for the encryption of each sector with a slight variation, enhancing the security of the data encryption on storage devices.

## MULTIPLE CHOICE

1. In the first instance of multiple encryption plaintext is converted to _____using the encryption algorithm.

   A) block cipher
   B) ciphertext
   C) S-AES mode
   D) Triple DES

   **Solution:** B

   **Explanation:** In the first instance of multiple encryption, plaintext is converted to ciphertext using the encryption algorithm.

2. Triple DES makes use of _____ stages of the DES algorithm, using a total of two or three distinct keys.

   A) nine
   B) six
   C) twelve
   D) three

   **Solution:** D

   **Explanation:** Triple DES uses three stages of the DES algorithm, potentially with two or three distinct keys.

3. Another important mode, XTS-AES, has been standardized by the _____ Security in Storage Working Group.

   A) IEEE
   B) ISO
   C) NIST
   D) ITIL

   **Solution:** A

   **Explanation:** XTS-AES has been standardized by the IEEE Security in Storage Working Group.

4. The _____ and _____ block cipher modes of operation are used for authentication.

   A) OFB, CTR
   B) ECB, CBC
   C) CFB, OFB
   D) CBC, CFB

   **Solution:** D

   **Explanation:** CBC (Cipher Block Chaining) and CFB (Cipher Feedback) modes of operation are used for authentication due to their ability to ensure message integrity in addition to confidentiality.

5. _____ modes of operation have been standardized by NIST for use with symmetric block ciphers such as DES and AES.

   A) Three
   B) Five
   C) Nine
   D) Seven

   **Solution:** B

   **Explanation:** NIST has standardized five modes of operation for use with symmetric block ciphers: ECB, CBC, CFB, OFB, and CTR.

6. The output of the encryption function is fed back to the shift register in Output Feedback mode, whereas in _____ the ciphertext unit is fed back to the shift register.

   A) Cipher Block Chaining mode
   B) Electronic Codebook mode
   C) Cipher Feedback mode
   D) Counter mode

   **Solution:** C

   **Explanation:** In Cipher Feedback mode, the ciphertext unit is fed back to the shift register, distinguishing it from Output Feedback mode where the output of the encryption function is used.

7. The simplest form of multiple encryption has _____ encryption stages and _____ keys.

   A) four, two
   B) two, three
   C) two, two
   D) three, two

   **Solution:** B

   **Explanation:** The simplest form of multiple encryption involves two encryption stages and the use of three keys.

8. The _____ algorithm will work against any block encryption cipher and does not depend on any particular property of DES.

   A) cipher block chaining
   B) meet-in-the-middle attack
   C) counter mode attack
   D) ciphertext stealing

   **Solution:** B

   **Explanation:** The meet-in-the-middle attack is an attack strategy that can work against any block encryption cipher and is not dependent on specific properties of DES.

9. The _____ method is ideal for a short amount of data and is the appropriate mode to use if you want to transmit a DES or AES key securely.

A) cipher feedback mode B) counter mode

C) output feedback mode D) electronic codebook mode

**Solution:** D

**Explanation:** Electronic Codebook (ECB) mode is suitable for encrypting a small amount of data securely, such as transmitting a key.

10. _____ mode is similar to Cipher Feedback, except that the input to the encryption algorithm is the preceding DES output.

A) Cipher Feedback B) Counter

C) Output Feedback D) Cipher Block Chaining

**Solution:** C

**Explanation:** Output Feedback (OFB) mode is similar to CFB except that the input to the encryption algorithm is the preceding output of the encryption algorithm.

11. "Each block of plaintext is XORed with an encrypted counter. The counter is incremented for each subsequent block", is a description of _____ mode.

A) Cipher Block Chaining B) Counter

C) Cipher Feedback D) Electronic Codebook

**Solution:** B

**Explanation:** Counter (CTR) mode encrypts each block of plaintext by XORing it with an encrypted counter, with the counter incremented for each block.

12. The _____ mode operates on full blocks of plaintext and ciphertext, as opposed to an s-bit subset.

A) CBC B) ECB

C) OFB D) CFB

**Solution:** A

**Explanation:** Cipher Block Chaining (CBC) mode operates on full blocks of plaintext and ciphertext, unlike CFB and OFB, which can operate on subsets of a block.

13. Because of the opportunities for parallel execution in _____ mode, processors that support parallel features, such as aggressive pipelining, multiple instruction dispatch per clock cycle, a large number of registers, and SIMD instructions can be effectively utilized.

    A) CBC
    B) CTR
    C) ECB
    D) CFB

    **Solution:** B

    **Explanation:** Counter (CTR) mode allows for parallel execution, making it efficient on processors that support parallel features.

14. _____ mode is suitable for parallel operation. Because there is no chaining, multiple blocks can be encrypted or decrypted simultaneously. Unlike CTR mode, this mode includes a nonce as well as a counter.

    A) OFB
    B) S-AES
    C) 3DES
    D) XTS-AES

    **Solution:** D

    **Explanation:** XTS-AES mode is suitable for parallel operation and includes a tweak (nonce) and a counter in its design, making it ideal for encrypting disk sectors.

15. Both _____ produce output that is independent of both the plaintext and the ciphertext. This makes them natural candidates for stream ciphers that encrypt plaintext by XOR one full block at a time.

    A) CBC and ECB
    B) OFB and CTR
    C) ECB and OFB
    D) CTR and CBC

    **Solution:** B

    **Explanation:** Both Output Feedback (OFB) and Counter (CTR) modes produce output independent of both the plaintext and ciphertext, making them suitable for use as stream ciphers.

## SHORT ANSWER

1. The Multiple encryption is a technique in which an encryption algorithm is used multiple times.

    **Solution:** Multiple encryption

    **Explanation:** Multiple encryption involves using an encryption algorithm several times with different keys or processes to enhance security.

2. The most significant characteristic of Electronic Codebook (ECB) mode is that if the same b-bit block of plaintext appears more than once in the message, it always produces the same ciphertext.

   **Solution:** Electronic Codebook (ECB) mode

   **Explanation:** In ECB mode, identical blocks of plaintext produce identical blocks of ciphertext, revealing patterns in the data.

3. A Mode of operation is a technique for enhancing the effect of a cryptographic algorithm or adapting the algorithm for an application, such as applying a block cipher to a sequence of data blocks or a data stream.

   **Solution:** Mode of operation

   **Explanation:** A mode of operation enhances the effect of a cryptographic algorithm or adapts it for specific applications, ensuring secure encryption of data sequences or streams.

4. Five modes of operation have been standardized by NIST for use with symmetric block ciphers such as DES and AES: electronic codebook mode, cipher block chaining mode, cipher feedback mode, Output Feedback (OFB) mode, and counter mode.

   **Solution:** Output Feedback (OFB) mode

   **Explanation:** Alongside ECB, CBC, CFB, and CTR, OFB mode has been standardized by NIST for use with symmetric block ciphers.

5. One of the most widely used multiple-encryption scheme is Triple DES (3DES).

   **Solution:** Triple DES (3DES)

   **Explanation:** One of the most widely used multiple-encryption schemes is Triple DES, which applies the DES algorithm three times to each data block for enhanced security.

6. ”The input to the encryption algorithm is the XOR of the next 64 bits of plaintext and the preceding 64 bits of ciphertext” is a description of Cipher Block Chaining (CBC) mode mode.

   **Solution:** Cipher Block Chaining (CBC) mode

   **Explanation:** In CBC mode, each block of plaintext is XORed with the preceding block of ciphertext before being encrypted, ensuring that the same plaintext block produces different ciphertext blocks.

7. The simplest mode of operation is the Electronic Codebook (ECB) mode mode, in which plaintext is handled one block at a time and each block of plaintext is encrypted using the same key.

**Solution:** Electronic Codebook (ECB) mode

**Explanation:** ECB mode is the simplest mode of operation, handling one block of plaintext at a time and encrypting each block independently with the same key.

8. The requirements for encrypting stored data, also referred to as Encrypting stored data , differ somewhat from those for transmitted data.

   **Solution:** Encrypting stored data

   **Explanation:** Encrypting stored data has specific requirements to ensure data security even when attackers can access the storage medium directly.

9. The Counter (CTR) mode block cipher mode of operation is a general purpose block oriented transmission useful for high speed requirements.

   **Solution:** Counter (CTR) mode

   **Explanation:** CTR mode is suitable for high-speed requirements and operates by encrypting counters and XORing the output with plaintext blocks.

10. ”Input is processed s bits at a time. Preceding ciphertext is used as input to the encryption algorithm to produce pseudorandom output, which is XORed with plaintext to produce next unit of ciphertext”, is a description of the Cipher Feedback (CFB) mode mode of operation.

    **Solution:** Cipher Feedback (CFB) mode

    **Explanation:** In CFB mode, input is processed in segments, and the encryption algorithm's output is used to produce pseudorandom output for XORing with plaintext to produce ciphertext.

11. The Initialization vector (IV) must be a data block that is unique to each execution of the encryption operation and may be a counter, a timestamp, or a message number.

    **Solution:** Initialization vector (IV)

    **Explanation:** The IV must be unique for each execution of the encryption operation, ensuring the same plaintext block produces different ciphertext blocks in different encryption instances.

12. A Stream cipher cipher can operate in real time and eliminates the need to pad a message to be an integral number of blocks.

    **Solution:** Stream cipher

    **Explanation:** A stream cipher encrypts data one bit or byte at a time, making it suitable for real-time operations and eliminating the need for padding.

13. Hardware efficiency, software efficiency, preprocessing, random access, provable security, and simplicity are all advantages of Counter (CTR) mode mode.

    **Solution:** Counter (CTR) mode

    **Explanation:** CTR mode offers advantages like hardware and software efficiency, and its parallelizable nature makes it ideal for modern cryptographic applications.

14. The plaintext of a sector or data unit is organized in to blocks of 128 bits. For encryption and decryption, each block is treated independently. The only exception occurs when the last block has less than 128 bits. In that case the last two blocks are encrypted/decrypted using a Ciphertext stealing technique instead of padding.

    **Solution:** Ciphertext stealing

    **Explanation:** Ciphertext stealing is used to encrypt or decrypt blocks with less than the standard size without the need for padding, ensuring data integrity and security.

15. The XTS-AES standard standard describes a method of encryption for data stored in sector-based devices where the threat model includes possible access to stored data by the adversary. Some characteristics of this standard include: the ciphertext is freely available for an attacker, the data layout is not changed on the storage medium and in transit, and the same plaintext is encrypted to different ciphertexts at different locations.

    **Solution:** XTS-AES standard

    **Explanation:** The XTS-AES standard addresses the encryption of data on sector-based storage devices, ensuring high levels of security even when attackers have direct access to the ciphertext.