Cyber Security (4353204) - Winter 2024 Solution

Milav Dabgar

November 27, 2024

Question 1(a) [3 marks]

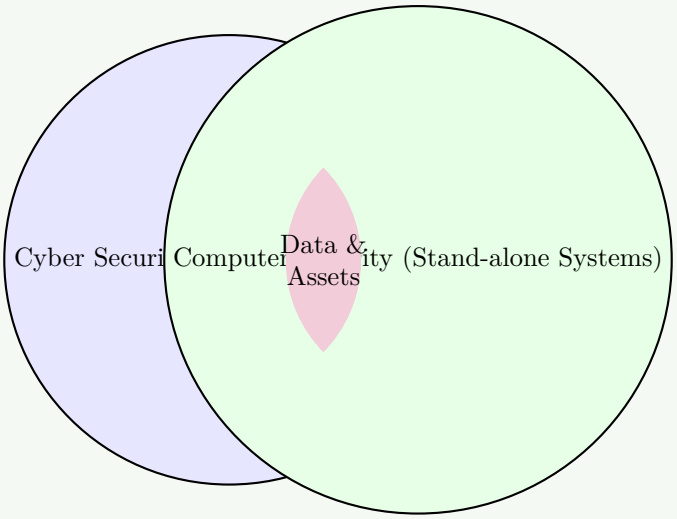
Define cyber security & computer security.

Solution

Definitions:

- **Cyber Security**: Protection of internet-connected systems including hardware, software, and data from cyber threats. It focuses on defending networks, devices, and programs from unauthorized digital attacks.
- **Computer Security**: Protection of individual computer systems and data from theft, damage, or unauthorized access. It focuses on safeguarding the physical computer hardware and the software installed on it.

Figure 1. Cyber Security vs Computer Security



Mnemonic

"Cyber Circles Networks, Computer Covers Machines"

Question 1(b) [4 marks]

Explain CIA triad.

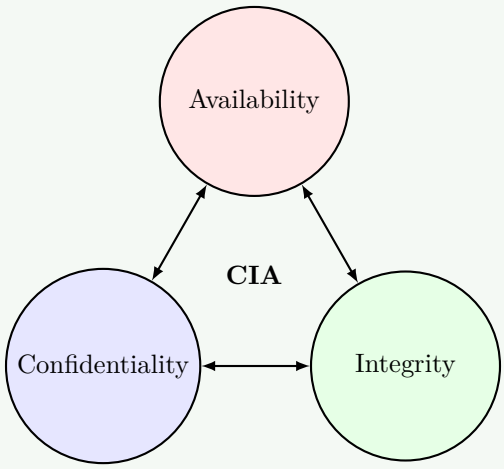
Solution

The CIA Triad: The CIA triad represents the three fundamental principles of information security:

Table 1. CIA Triad Principles

Principle	Description
Confidentiality	Ensures that sensitive information is accessible only to authorized parties
Integrity	Guarantees that data remains accurate and unaltered during storage and transmission
Availability	Ensures systems and data are accessible when needed by authorized users

Figure 2. CIA Triad



Mnemonic

"CIA Keeps Information Properly Accessible"

Question 1(c) [7 marks]

Define adversary, attack, countermeasure, risk, security policy, system resource, and threat in the context of computer security.

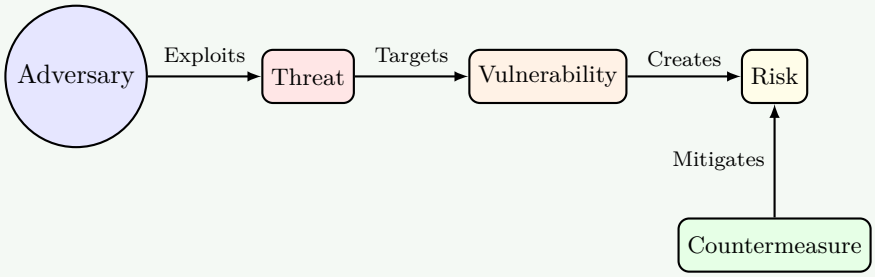
Solution

Key Definitions:

Table 2. Security Terminology

Term	Definition
Adversary	Individual or group that attempts to exploit vulnerabilities for malicious purposes
Attack	Deliberate action to compromise security by exploiting vulnerabilities in a system
Countermeasure	Controls implemented to mitigate or eliminate security vulnerabilities
Risk	Potential for loss or damage when a threat exploits a vulnerability
Security Policy	Documented rules that define acceptable use and protection requirements
System Resource	Hardware, software, data, or network components that require protection
Threat	Potential danger that might exploit a vulnerability to breach security

Figure 3. Security Threat Model



Mnemonic

"ARTSVSC: All Resources Typically Secure Various System Components"

Question 1(c OR) [7 marks]

Explain MD5 hashing algorithm.

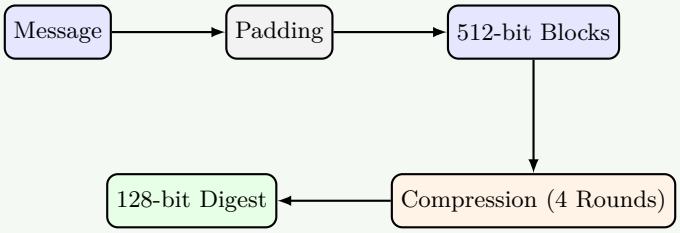
Solution

MD5 (Message Digest 5): MD5 is a widely used cryptographic hash function that produces a 128-bit (16-byte) hash value.

Process Steps:

1. **Input Processing**: Message is padded and divided into 512-bit blocks
2. **Initialization**: Sets up four 32-bit registers with fixed values
3. **Compression**: Processes message in 16-word blocks through four rounds of operations
4. **Output**: Produces 128-bit digest as final hash value

Figure 4. MD5 Algorithm Process



- **Weakness**: Not collision-resistant; shouldn't be used for security-critical applications
- **Usage**: File integrity verification and non-security critical applications

Mnemonic

"Pad, Divide, Process, Output - Don't Use For Security!"

Question 2(a) [3 marks]

Define authentication in context of cyber security.

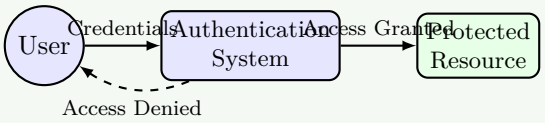
Solution

Authentication Definition: Authentication is the process of verifying the identity of a user, system, or entity before granting access to resources.

- **Confirms**: "You are who you claim to be"

- **Verifies**: Identity using credentials (passwords, biometrics, tokens)
- **Precedes**: Authorization (what you can access after authentication)

Figure 5. Authentication Process



Mnemonic

"Verify Before Entry"

Question 2(b) [4 marks]

Explain public key cryptography with example.

Solution

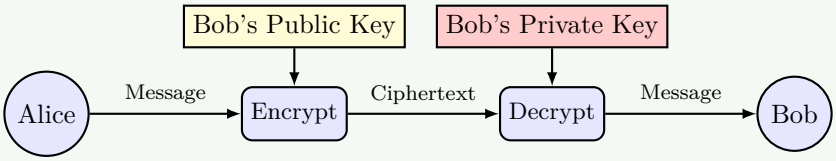
Public Key Cryptography (Asymmetric): Uses two mathematically related keys for secure communication:

Table 3. Key Functions

Component	Function
Public Key	Shared openly and used to encrypt messages
Private Key	Kept secret and used to decrypt messages

Example: In RSA encryption, if Alice wants to send Bob a message:
1. Alice encrypts with Bob's public key
2. Only Bob can decrypt using his private key

Figure 6. Public Key Cryptography Example



Mnemonic

"Public to Lock, Private to Unlock"

Question 2(c) [7 marks]

Explain working of packet filter and application proxy.

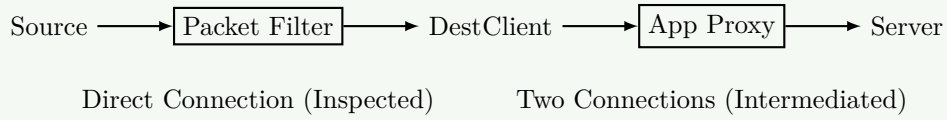
Solution

Firewall Types:

Table 4. Packet Filter vs Application Proxy

Fire-wall Type	Working
Packet Filter	Examines packet headers based on predefined rules. Makes decisions based on source/destination IP addresses, ports, and protocols. Works at OSI network and transport layers. Offers high-speed filtering with low resource usage.
Appli-cation Proxy	Acts as intermediary between client and server applications. Processes all traffic at application layer. Creates two connections (client-to-proxy and proxy-to-server). Provides content inspection and user authentication capabilities.

Figure 7. Packet Filter vs Proxy



Mnemonic

"Packets Check Headers, Proxies Check Content"

Question 2(a OR) [3 marks]

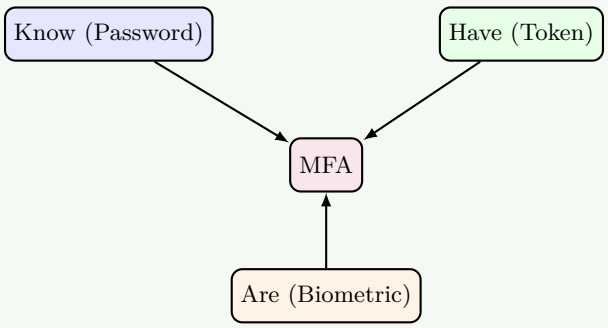
Explain multi-factor authentication.

Solution

Multi-Factor Authentication (MFA): Requires users to provide two or more verification factors to gain access to a resource:

- **Something you know**: Password, PIN, security question
- **Something you have**: Mobile phone, smart card, security token
- **Something you are**: Fingerprint, facial recognition, voice pattern

Figure 8. MFA Components



Mnemonic

"Know, Have, Are - Triple Security"

Question 2(b OR) [4 marks]

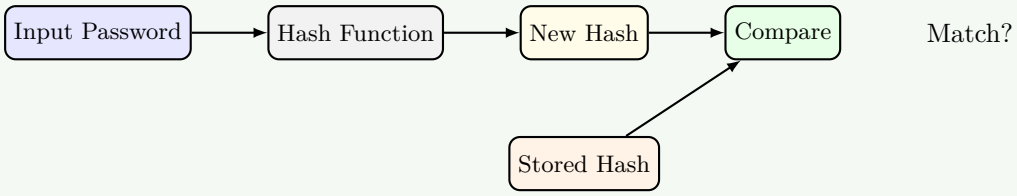
Explain the process of password verification.

Solution

Process: Password verification authenticates user credentials against stored values:

1. **User Input**: User enters username and password
2. **Hash Generation**: System hashes the entered password
3. **Comparison**: Hash is compared with stored hash in database
4. **Access Decision**: Access granted if hashes match, denied if not

Figure 9. Verification Flow



Mnemonic

"Enter, Hash, Compare, Decide"

Question 2(c OR) [7 marks]

List out malicious software and explain any three malicious software attacks.

Solution

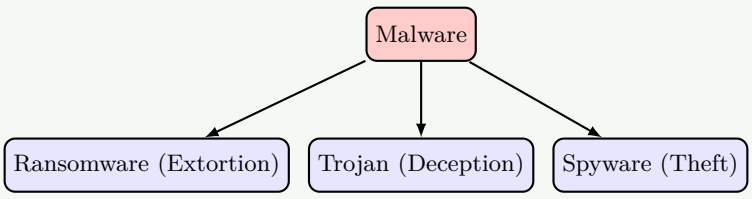
Malicious Software Types: Viruses, Worms, Trojans, Ransomware, Spyware, Adware, Rootkits, Keyloggers, Bots.

Three Common Attacks:

Table 5. Malware Types

Attack Type	Explanation
Ransomware	Encrypts victim's files and demands payment for decryption key. Spreads through phishing emails, malicious downloads, or exploiting vulnerabilities. Example: WannaCry.
Trojans	Disguised as legitimate software but performs malicious actions. Creates backdoors for attackers to access systems. Example: Remote Access Trojans (RATs).
Spyware	Collects user information without consent. Monitors activities, keystrokes, and browsing habits. Can steal passwords and financial information.

Figure 10. Malware Classification



Mnemonic

"RTS: Ransom Takes Systems, Trojans Sneak In, Spyware Steals Info"

Question 3(a) [3 marks]

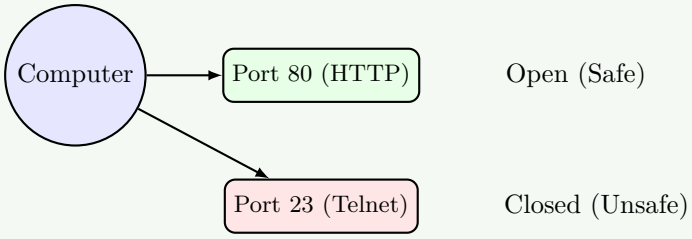
Explain the importance of ports in cyber security.

Solution

Importance of Ports: Ports are virtual endpoints for network communications that:

- **Identify Services**: Each service uses specific port numbers (HTTP:80, HTTPS:443)
- **Enable Filtering**: Firewalls control traffic by allowing/blocking specific ports
- **Reduce Attack Surface**: Closing unnecessary ports enhances security

Figure 11. Port Security



Mnemonic

"Every Port Is An Entry Point"

Question 3(b) [4 marks]

Explain Virtual private network.

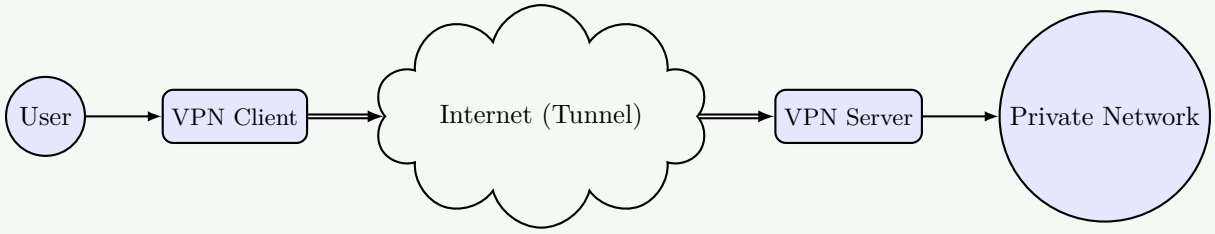
Solution

Virtual Private Network (VPN): A technology that creates a secure connection over public networks.

Table 6. VPN Features

Feature	Description
Encrypted Tunnel	Creates secure connection over public networks
IP Masking	Hides user's IP address and location
Data Protection	Encrypts data during transmission
Remote Access	Enables secure connection to private networks

Figure 12. VPN Architecture



Mnemonic

"Tunnel, Encrypt, Protect, Connect"

Question 3(c) [7 marks]

Explain the impact of web security threats.

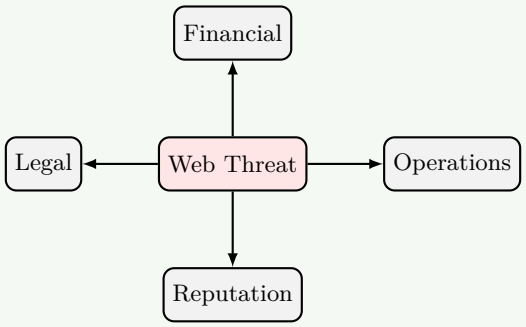
Solution

Impacts:

Table 7. Web Threat Impacts

Impact	Description
Data Breaches	Exposure of sensitive information leading to financial losses and reputation damage
Financial Loss	Direct monetary theft, fraud, recovery costs, and regulatory fines
Operational Disruption	System downtime affecting business continuity and customer service
Reputation Damage	Loss of customer trust and brand value after security incidents
Legal Consequences	Litigation, regulatory penalties, and compliance violations

Figure 13. Impact Areas



Mnemonic

"DFROL: Data, Finances, Resources, Opinion, Legal"

Question 3(a OR) [3 marks]

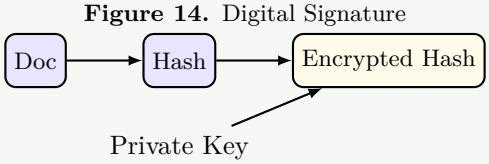
Explain working of digital signature.

Solution

Digital Signature Process:

1. **Hash Creation**: Document is hashed to create a unique digest
2. **Encryption**: Sender encrypts the hash using their private key
3. **Verification**: Recipient decrypts using sender's public key
4. **Validation**: Comparing decrypted hash with newly generated hash

Figure 14. Digital Signature



Mnemonic

"Hash, Sign, Send, Verify"

Question 3(b OR) [4 marks]

Describe HTTPS.

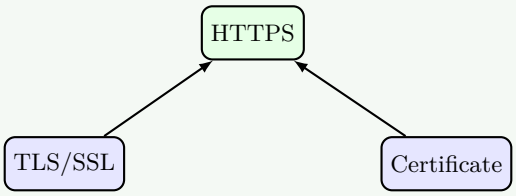
Solution

HTTPS (Secure HTTP):

Table 8. HTTPS Components

Feature	Description
TLS/SSL	Uses Transport Layer Security to encrypt data
Authentication	Verifies website identity through certificates
Data Integrity	Prevents tampering of transmitted data
Port 443	Uses default port 443 instead of HTTP's port 80

Figure 15. HTTPS Lock



Mnemonic

"Secured Pages Show Padlock"

Question 3(c OR) [7 marks]

Explain social engineering, vishing and machine in the middle attack.

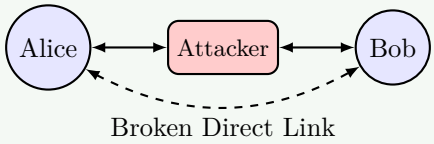
Solution

Attack Explanations:

Table 9. Attack Types

Attack Type	Explanation
Social Engineering	Psychological manipulation to trick users into revealing sensitive information. Exploits human trust rather than technical vulnerabilities. Common techniques include pretexting, baiting, and phishing.
Vishing	Voice phishing using phone calls to steal information. Attackers impersonate legitimate organizations. Often uses urgency or fear to manipulate victims.
Machine in the Middle	Attacker secretly intercepts and relays communication between two parties. Victims believe they're communicating directly with each other. Allows attackers to steal/modify sensitive information during transmission.

Figure 16. MITM Attack



Mnemonic

"SEVeM: Social Engineers Voice Messages and Mediate connections"

Question 4(a) [3 marks]

Match the following.

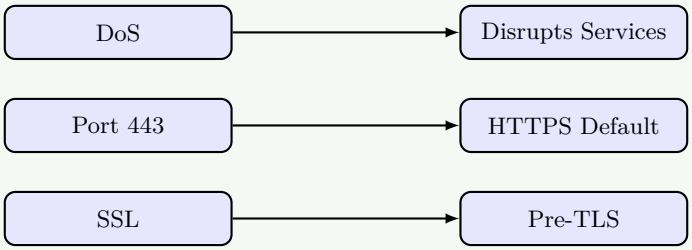
Solution

Correct Pairs:

Table 10. Matching Pairs

Term	Corresponding Description
1. Denial of Service (DoS)	f. Attack that disrupts network services
2. Port 443	c. Default port for HTTPS
3. Secure Socket Layer (SSL)	e. Predecessor of TLS for secure communication
4. Port 80	b. Default port for HTTP
5. Integrity	a. Ensures data is not altered during transmission
6. VPN (Virtual Private Network)	d. Creates a secure connection over the internet

Figure 17. Matching Flow



Mnemonic

"Disrupt HTTPS, Secure HTTP, Intact VPN"

Question 4(b) [4 marks]

List out types of hackers and explain role of each.

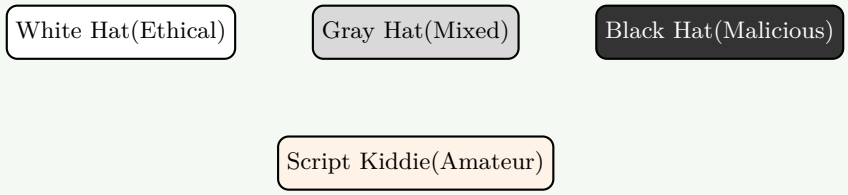
Solution

Hacker Types:

Table 11. Hacker Roles

Type	Role
White Hat	Ethical hackers who test systems with permission to improve security
Black Hat	Malicious hackers who exploit vulnerabilities for personal gain or damage
Gray Hat	Operate between ethical and malicious; may hack without permission but disclose findings
Script Kiddies	Inexperienced hackers using pre-written scripts without understanding the technology

Figure 18. Hacker Hat Colors



Mnemonic

"White Protects, Black Attacks, Gray Mixes, Kids Script"

Question 4(c) [7 marks]

Explain SSH (Secure shell) protocol stack.

Solution

SSH Protocol Stack: SSH provides secure remote access and file transfers through a layered architecture:

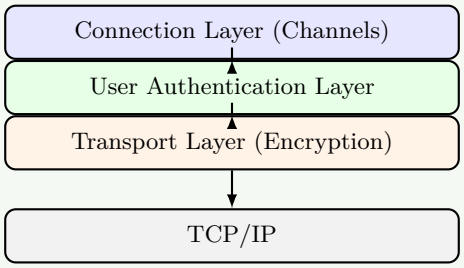
Table 12. SSH Layers

Layer	Function
Transport Layer	Handles encryption, server authentication, and data integrity
User Authentication Layer	Verifies client identity using passwords, keys, or certificates
Connection Layer	Manages multiple channels within a single SSH connection

Key Features:

- Strong encryption (AES, 3DES)
- Public key authentication
- Data integrity checking
- Port forwarding and tunneling

Figure 19. SSH Stack



Mnemonic

"Transport Secures, Users Authenticate, Connections Multiplex"

Question 4(a OR) [3 marks]

Explain foot printing in ethical hacking.

Solution

Footprinting: The first phase of ethical hacking where information is gathered about the target.

- **Purpose**: Collecting data about network, systems, and organization
- **Methods**: WHOIS lookup, DNS analysis, social media research
- **Outcomes**: Identifying potential entry points and vulnerabilities

Figure 20. Footprinting Phase

Mnemonic

"Gather Before Attack"

Question 4(b OR) [4 marks]

Explain scanning in ethical hacking.

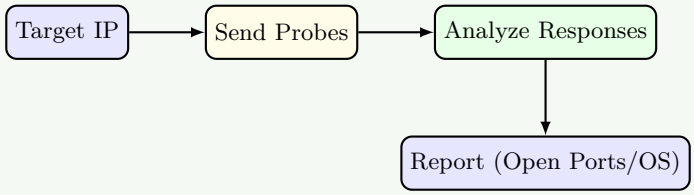
Solution

Scanning Process: Actively probing a target system to identify live hosts, open ports, and services.

Table 13. Scanning Techniques

Technique	Purpose
Port Scanning	Identifies open ports and running services
Vulnerability Scanning	Detects known security weaknesses
Network Mapping	Discovers network topology and devices
OS Fingerprinting	Determines operating system versions

Figure 21. Scanning Workflow



Mnemonic

"PONS: Ports Open, Network Services"

Question 4(c OR) [7 marks]

Describe injection attack and phishing attack.

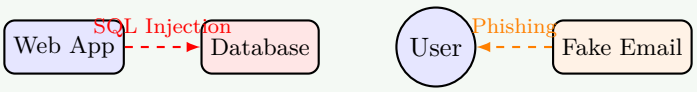
Solution

Comparisons:

Table 14. Attack Descriptions

Attack Type	Description
Injection Attack	Inserts malicious code into vulnerable applications. Common types include SQL injection, command injection, and XSS. Exploits poor input validation. Can lead to data theft, modification, or destruction. Prevented through input sanitization and parameterized queries.
Phishing Attack	Social engineering attack using fake websites/emails. Attempts to steal credentials, financial information, or install malware. Often mimics trusted organizations. Contains urgent call-to-action to create panic. Prevented through education, email filtering, and multi-factor authentication.

Figure 22. Injection vs Phishing



Mnemonic

"Inject Code, Phish People"

Question 5(a) [3 marks]

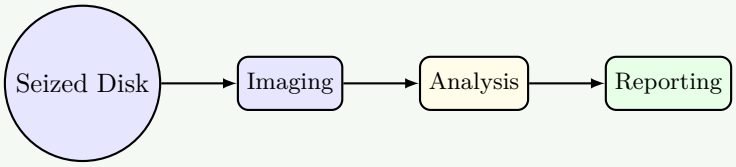
Explain disk forensics.

Solution

Disk Forensics: Examination of storage media to recover, analyze, and preserve digital evidence.

- **Purpose**: Recover deleted files, analyze file systems, and establish timelines
- **Methods**: Bit-by-bit imaging, hash verification, and specialized tools
- **Applications**: Criminal investigations, corporate security incidents, data recovery

Figure 23. Disk Forensics Cycle



Mnemonic

"Recover, Analyze, Present"

Question 5(b) [4 marks]

Explain password cracking methods.

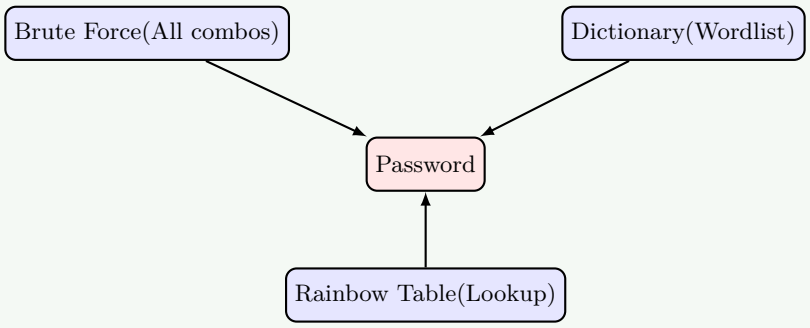
Solution

Cracking Methods:

Table 15. Methods Table

Method	Description
Brute Force	Tries all possible character combinations systematically
Dictionary Attack	Uses list of common words and variations
Rainbow Table	Pre-computed tables of password hashes for quick lookup
Social Engineering	Manipulates users to reveal passwords

Figure 24. Cracking Techniques



Mnemonic

"BDRS: Brute Dictionary Rainbow Social"

Question 5(c) [7 marks]

Describe Remote Administration Tool (RAT).

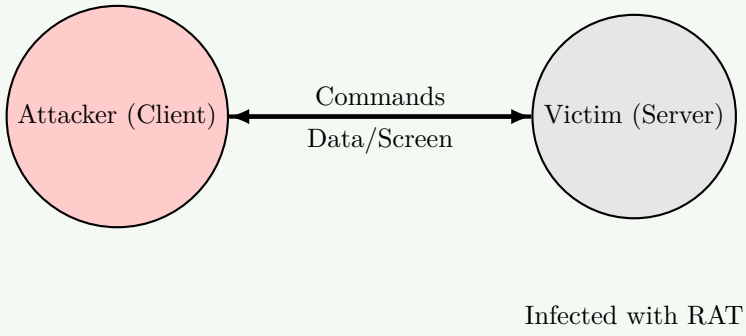
Solution

Remote Administration Tool (RAT): Software that enables remote control of a computer system.

Table 16. RAT Details

Aspect	Description
Functionality	Provides complete control over target system including file access, screen viewing, and keylogging
Deployment	Often installed through phishing, bundled with legitimate software, or via exploited vulnerabilities
Architecture	Client-server model where server runs on victim's machine and client is controlled by attacker
Legitimate Uses	IT support, remote work, and system administration
Malicious Uses	Unauthorized surveillance, data theft, and sabotage

Figure 25. RAT Architecture



Mnemonic

"RCASD: Remote Control Access Steals Data"

Question 5(a OR) [3 marks]

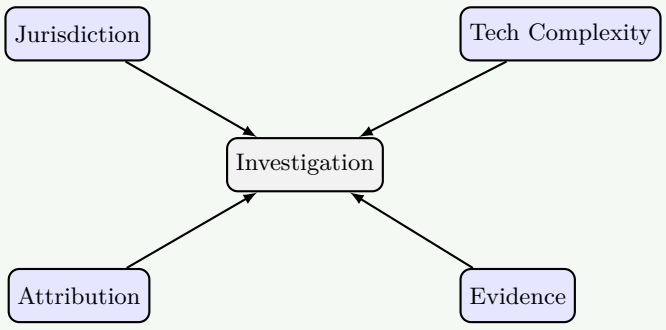
List out challenges of cybercrime.

Solution

Major Challenges:

- **Jurisdiction Issues**: Crimes crossing international boundaries
- **Technical Complexity**: Constantly evolving attack methods
- **Attribution Problems**: Difficulty identifying perpetrators
- **Evidence Collection**: Volatile and easily altered digital evidence

Figure 26. Cybercrime Challenges



Mnemonic

"JTAE: Jurisdictions, Technology, Attribution, Evidence"

Question 5(b OR) [4 marks]

Explain mobile forensics.

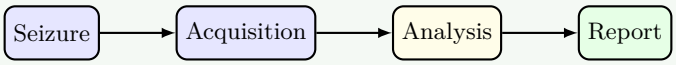
Solution

Mobile Forensics: The science of recovering digital evidence from mobile devices.

Table 17. Forensics Aspects

Aspect	Description
Data Types	Call logs, messages, location data, photos, app data
Challenges	Encryption, diverse operating systems, anti-forensic techniques
Methods	Physical extraction, logical acquisition, file system analysis
Tools	Cellebrite UFED, Oxygen Forensic, Magnet AXIOM

Figure 27. Mobile Forensics Steps



Mnemonic

"GEAR: Get Evidence, Analyze, Report"

Question 5(c OR) [7 marks]

Explain Salami Attack, Web Jacking, Data diddling and Ransomware attack.

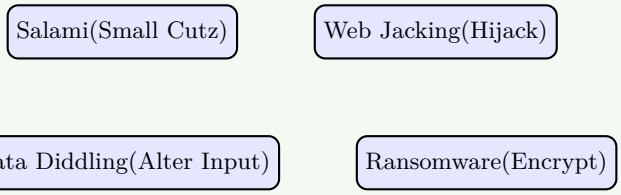
Solution

Attack Varieties:

Table 18. Attack Types

Attack Type	Description
Salami Attack	Series of minor theft actions that go unnoticed individually. Often involves modifying financial transactions by taking small amounts. Cumulative effect can be significant over time. Example: Rounding bank transactions and collecting fractions.
Web Jacking	Hijacking a website by changing its content or redirecting to fake site. Involves domain theft or DNS manipulation. Used for distributing malware or collecting sensitive information.
Data Diddling	Unauthorized modification of data before/during input to system. Changes are typically small and hard to detect. Affects data integrity and can lead to wrong business decisions.
Ransomware	Malware that encrypts victim's files and demands payment for decryption. Typically spreads through phishing or exploiting vulnerabilities. Notable examples include WannaCry and Ryuk.

Figure 28. Attack Methods



Mnemonic

"SWDR: Small slices, Websites hijacked, Data altered, Ransom demanded"