LINCOLN UNIVERSITY COLLEGE
DKU016 (B)

ASSIGNMENT COVER PAGE

Please fill in all the required details for your assignment to be accepted.

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Year/Semester	Year 3/ Semester 8		
Program	Software Engineering		
Subject Name / Subject	**BIT 6314**		
Lecturer's Name	**Mr jafar**		
Assignment Title	Linux task		
No. of Page (excluding this page)	**1**		
Required words		Actual of words	
Soft copy included	**Yes / No**		

DECLARATION BY STUDENTS:

I certify that this assignment is my own work in my own words. All resources have been acknowledged and the content has not been previously submitted for assessment to LINCOLN or elsewhere. I also confirm that I have kept a copy of this assignment.

Sign: Daniel **Date: 07/09/2025**

1, **User & Group Management Automation (7 Marks)**

Write a Bash script that will automate the following tasks:

- Create 5 new users
- Add them to a group called `devteam`
- Set their passwords
- Force them to change their password upon first login

Step-by-Step Instructions

Step 1: Create the Script File

After connecting to your VPS, run the following command to create and open the script file:

```
sudo nano user_group_management.sh
```

Once the nano editor opens:

- Write or paste your script
- To save and exit:
    - Press *Cmd* + *X* (or *Ctrl* + *X* on most keyboards)
    - Press *Y* to confirm saving
    - Then press *Enter* to finalize

Step 2: Make the Script Executable

Run this command to give the script execution permission:

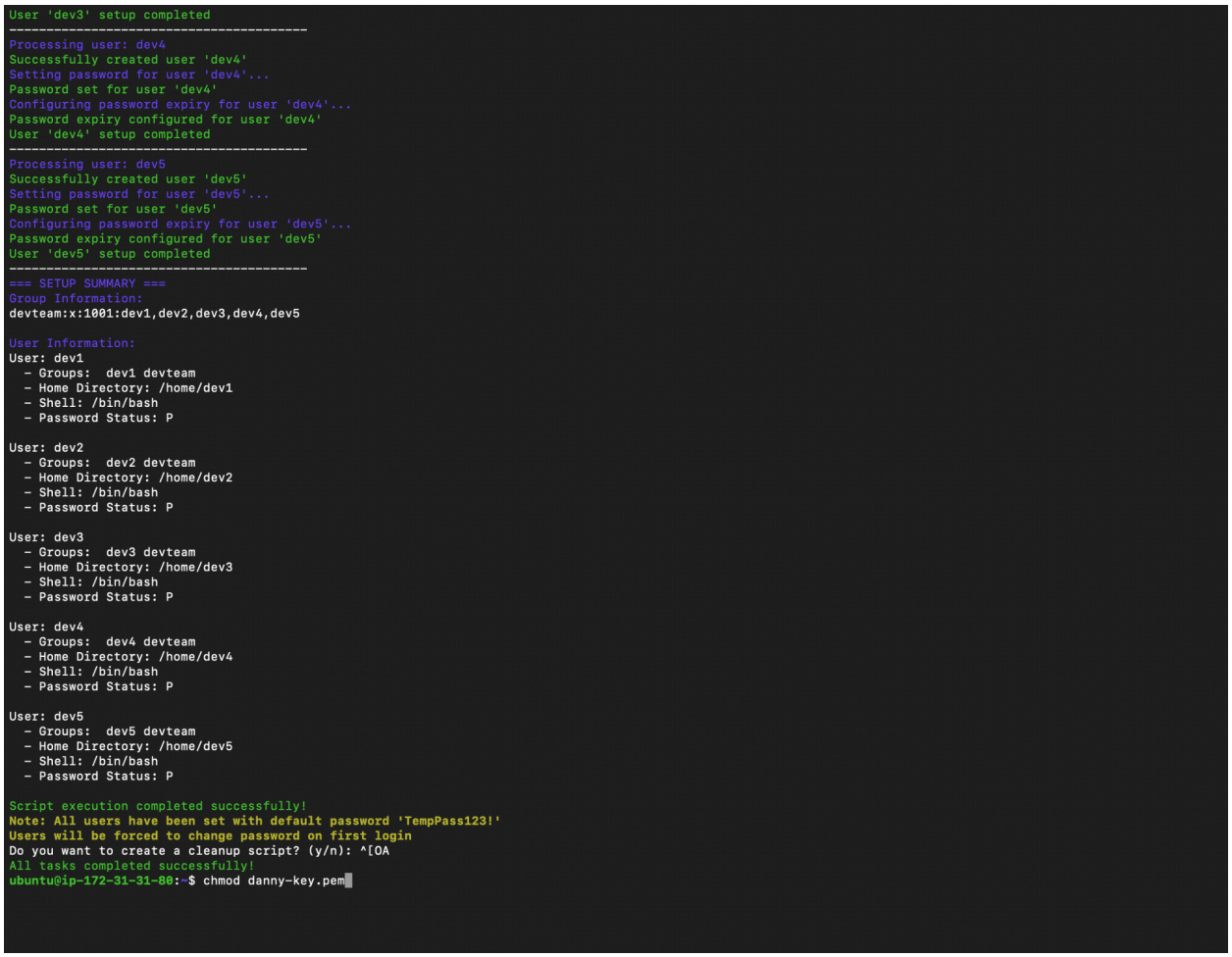
```
sudo chmod +x user_group_management.sh
```

Step 3: Execute the Script

Finally, run the script using:

```
sudo ./user_group_management.sh
```

Let me know if you'd like help writing or formatting the actual script content inside `user_group_management.sh`.



2, **File Permissions & ACLs Project (6 Marks)**

Create a shared directory `/shared_data` where group members can read and write files, but cannot delete files created by others. Additionally, use ACL (Access Control Lists) to give **read-only access** to one extra user outside the group.

Step 1: Install ACL Utilities

Update the package index and install ACL:

```
sudo apt update
 sudo apt install acl -y
```

```
Get:27 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/main amd64 Packages [39.9 kB]
Get:28 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/main Translation-en [9152 B]
Get:29 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/main amd64 Components [7076 B]
Get:30 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/main amd64 c-n-f Metadata [272 B]
Get:31 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/universe amd64 Packages [30.2 kB]
Get:32 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/universe Translation-en [17.4 kB]
Get:33 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/universe amd64 Components [19.2 kB]
Get:34 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/universe amd64 c-n-f Metadata [1304 B]
Get:35 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/restricted amd64 Components [216 B]
Get:36 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/restricted amd64 c-n-f Metadata [116 B]
Get:37 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/multiverse amd64 Components [212 B]
Get:38 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports/multiverse amd64 c-n-f Metadata [116 B]
Get:39 http://security.ubuntu.com/ubuntu noble-security InRelease [126 kB]
Get:40 http://security.ubuntu.com/ubuntu noble-security/main amd64 Packages [1118 kB]
Get:41 http://security.ubuntu.com/ubuntu noble-security/main Translation-en [191 kB]
Get:42 http://security.ubuntu.com/ubuntu noble-security/main amd64 Components [21.6 kB]
Get:43 http://security.ubuntu.com/ubuntu noble-security/main amd64 c-n-f Metadata [8712 B]
Get:44 http://security.ubuntu.com/ubuntu noble-security/universe amd64 Packages [879 kB]
Get:45 http://security.ubuntu.com/ubuntu noble-security/universe Translation-en [194 kB]
Get:46 http://security.ubuntu.com/ubuntu noble-security/universe amd64 Components [52.3 kB]
Get:47 http://security.ubuntu.com/ubuntu noble-security/universe amd64 c-n-f Metadata [18.0 kB]
Get:48 http://security.ubuntu.com/ubuntu noble-security/restricted amd64 Packages [1705 kB]
Get:49 http://security.ubuntu.com/ubuntu noble-security/restricted Translation-en [382 kB]
Get:50 http://security.ubuntu.com/ubuntu noble-security/restricted amd64 Components [208 B]
Get:51 http://security.ubuntu.com/ubuntu noble-security/multiverse amd64 Packages [18.5 kB]
Get:52 http://security.ubuntu.com/ubuntu noble-security/multiverse Translation-en [4288 B]
Get:53 http://security.ubuntu.com/ubuntu noble-security/multiverse amd64 Components [208 B]
Get:54 http://security.ubuntu.com/ubuntu noble-security/multiverse amd64 c-n-f Metadata [380 B]
Fetched 37.0 MB in 6s (6564 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
13 packages can be upgraded. Run 'apt list --upgradable' to see them.
ubuntu@ip-172-31-31-80:~$ sudo apt install acl -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  acl
0 upgraded, 1 newly installed, 0 to remove and 13 not upgraded.
Need to get 39.4 kB of archives.
After this operation, 197 kB of additional disk space will be used.
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/main amd64 acl amd64 2.3.2-1build1.1 [39.4 kB]
Fetched 39.4 kB in 0s (2617 kB/s)
Selecting previously unselected package acl.
(Reading database ... 71718 files and directories currently installed.)
Preparing to unpack .../acl_2.3.2-1build1.1_amd64.deb ...
Unpacking acl (2.3.2-1build1.1) ...
Setting up acl (2.3.2-1build1.1) ...
Processing triggers for man-db (2.12.0-4build2) ...
Scanning processes...
Scanning linux images...

Running kernel seems to be up-to-date.

No services need to be restarted.

No containers need to be restarted.

No user sessions are running outdated binaries.

No VM guests are running outdated hypervisor (qemu) binaries on this host.
ubuntu@ip-172-31-31-80:~$
```

Step 2: Create the Shared Directory

Create the directory that will be shared:

```
sudo mkdir /shared_data
```

Step 3: Create Group and Users

Create a new group and three test users:

```
sudo groupadd datagroup
 sudo useradd -m user1
```

```
sudo useradd -m user2
sudo useradd -m readonly_user
```

Step 4: Add Users to the Group

Add `user1` and `user2` to the `datagroup`:

```
sudo usermod -aG datagroup user1
sudo usermod -aG datagroup user2
```

Step 5: Set Directory Ownership and Permissions

Assign group ownership of the shared directory and set permissions:

```
sudo chown root:datagroup /shared_data
sudo chmod 2775 /shared_data
```

The `2` in `2775` sets the **setgid** bit, ensuring that new files inherit the group.

Step 6: Set Sticky Bit

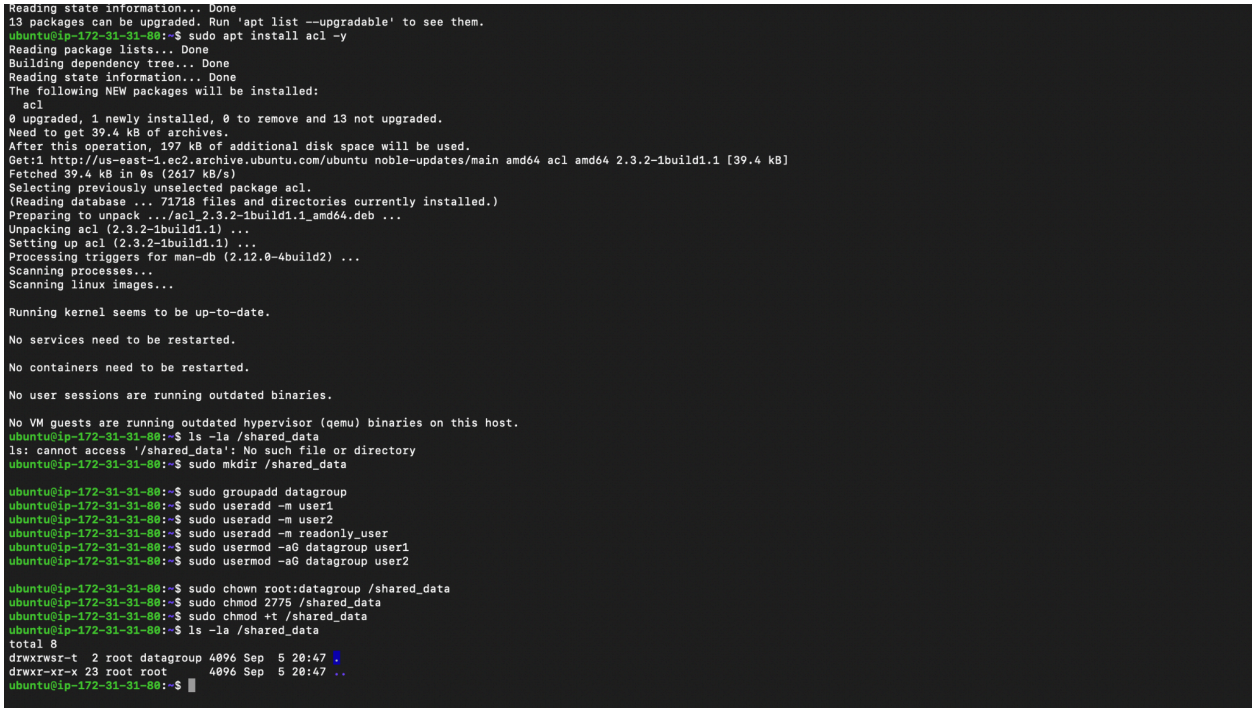
Set the **sticky bit** to prevent users from deleting each other's files:

```
sudo chmod +t /shared_data
```

Step 7: Verify Directory Permissions

Check the current permissions:

```
ls -la /shared_data
```



You should see something like:
drwxrwsr-t 2 root datagroup 4096 ... /shared_data

Step 8: Set ACL for Read-Only User

Grant `readonly_user` read and execute permissions:

```
sudo setfacl -m u:readonly_user:r-x /shared_data
sudo setfacl -m d:u:readonly_user:r-x /shared_data
```

The second command sets **default ACLs** for future files.

Step 9: View ACL Settings

Check the current ACLs on the directory:

```
getfacl /shared_data
```

```
Last login: Fri Sep  5 20:44:04 2025 from 105.115.7.252
ubuntu@ip-172-31-31-80:~$ getfacl /shared_data
getfacl: Removing leading '/' from absolute path names
# file: shared_data
# owner: root
# group: datagroup
# flags: -st
user::rwx
group::rwx
other::r-x

ubuntu@ip-172-31-31-80:~$
```

Step 10: Test Group Member File Creation

Switch to `user1` and create a file:

```
sudo su - user1
touch /shared_data/user1_file.txt
echo "Content by user1" > /shared_data/user1_file.txt
exit
```

Now switch to `user2` and do the same:

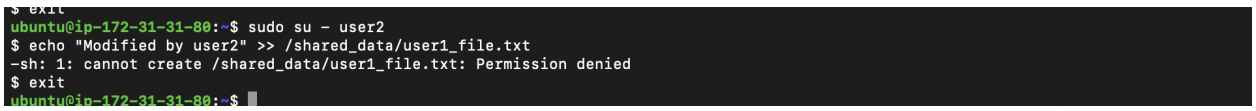
```
sudo su - user2
touch /shared_data/user2_file.txt
echo "Content by user2" > /shared_data/user2_file.txt
exit
```

```
ubuntu@ip-172-31-31-80:~$ sudo su - user1
$ touch /shared_data/user1_file.txt
$ echo "Content by user1" > /shared_data/user1_file.txt
$ exit
ubuntu@ip-172-31-31-80:~$ sudo su - user2
$ touch /shared_data/user2_file.txt
$ echo "Content by user2" > /shared_data/user2_file.txt
$ exit
ubuntu@ip-172-31-31-80:~$
```

Step 11: Test Write Access Between Group Members

Check if `user2` can modify `user1`'s file:

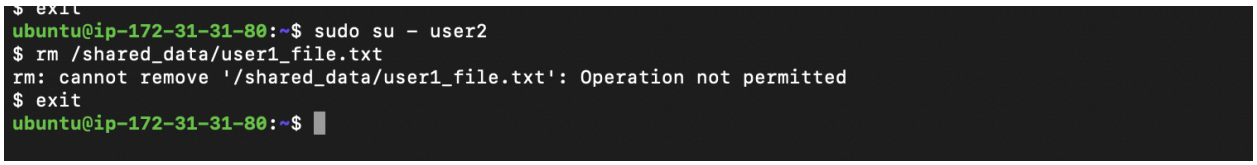
```
sudo su - user2
echo "Modified by user2" >> /shared_data/user1_file.txt
Exit
```



Step 12: Test Deletion Prevention

Attempt to delete another user's file (should fail):

```
sudo su - user2
rm /shared_data/user1_file.txt
# This should fail due to the sticky bit
Exit
```



Step 13: Test Read-Only Access for `readonly_user`

Switch to `readonly_user`:

```
sudo su - readonly_user
ls -la /shared_data
cat /shared_data/user1_file.txt
```

Attempt to create a new file (should fail):

touch /shared_data/readonly_test.txt
Exit

Apache Virtual Hosts Setup

Configure Apache to host **two separate websites** — `site1.local` and `site2.local` — each with its own document root and log files.

Step 1: Create the Setup Script

Create a new Bash script to automate the setup:

nano apache_virtual_hosts_setup.sh

Inside the file, you would typically include commands to:

- Create directories for each site
- Create index.html files
- Set permissions
- Create virtual host config files
- Enable the sites
- Reload Apache

After writing or pasting your script, save and exit:
Press *Ctrl* + *X*, then *Y*, then *Enter*.

Step 2: Make the Script Executable

Give the script execution permissions:

```
chmod +x apache_virtual_hosts_setup.sh
```

Step 3: Run the Script

Execute the script with superuser privileges:

```
sudo ./apache_virtual_hosts_setup.sh
```

Step 4: Add Entries to the Hosts File

Edit your local `/etc/hosts` file to map the domain names:

```
sudo nano /etc/hosts
```

Add the following lines:

127.0.0.1 site1.local

127.0.0.1 site2.local

Save and exit the file:
Press *Ctrl* + *X*, then *Y*, then *Enter*.

Step 5: Test the Setup

Use `curl` to verify that the sites are working:

```
curl http://site1.local
```

You should see the HTML content returned from your site.

Repeat for the second site if needed:

```
curl http://site2.local
```

4, **SSL/TLS Implementation (6 Marks)**

In this task, you will generate a self-signed SSL certificate using `openssl` and enable HTTPS for one of your virtual hosts on Apache.

Step 1: Verify OpenSSL Installation

Check if OpenSSL is installed by typing:

```
openssl version
```

Step 2: Create Directories for SSL Certificates

Create the necessary directories and set proper permissions:

```
sudo mkdir -p /etc/ssl/private
sudo mkdir -p /etc/ssl/certs
```

Set permissions:

```
sudo chmod 700 /etc/ssl/private
sudo chmod 755 /etc/ssl/certs
```

Step 3: Generate a Private Key

Generate a 2048-bit RSA private key:

```
sudo openssl genrsa -out /etc/ssl/private/example.com.key 2048
```

Secure the private key:

```
sudo chmod 600 /etc/ssl/private/example.com.key
```

Step 4: Generate a Certificate Signing Request (CSR)

Create a CSR using the private key:

```
sudo openssl req -new -key /etc/ssl/private/example.com.key -out
/etc/ssl/certs/example.com.csr
```

```
40E7B16E097B0000:error:80000002:system library:file_open:No such file or directory:../providers/implementations/storemgmt/file_store.c:267
ubuntu@ip-172-31-31-80:~$
sudo openssl genrsa -out /etc/ssl/private/example.com.key 2048
ubuntu@ip-172-31-31-80:~$ sudo chmod 600 /etc/ssl/private/example.com.key


ubuntu@ip-172-31-31-80:~$ sudo openssl req -new -key /etc/ssl/private/example.com.key -out /etc/ssl/certs/example.com.csr
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]:      NG
String too long, must be at most 2 bytes long
Country Name (2 letter code) [AU]:NG
State or Province Name (full name) [Some-State]:ABUJA
Locality Name (eg, city) []:ABUJA
Organization Name (eg, company) [Internet Widgits Pty Ltd]:LINCOLN
Organizational Unit Name (eg, section) []:12345
Common Name (e.g. server FQDN or YOUR name) []:DANIE
Email Address []:

Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []:
An optional company name []:NONE
ubuntu@ip-172-31-31-80:~$
```

Step 5: Generate a Self-Signed SSL Certificate

Use the CSR and private key to generate a self-signed certificate valid for 365 days:

```
sudo openssl x509 -req -days 365 -in /etc/ssl/certs/example.com.csr -signkey /etc/ssl/private/example.com.key -out /etc/ssl/certs/example.com.crt
```

Set permissions on the certificate:

```
sudo chmod 644 /etc/ssl/certs/example.com.crt
```

```
ubuntu@ip-172-31-31-80:~$ sudo openssl x509 -req -days 365 -in /etc/ssl/certs/example.com.csr -signkey /etc/ssl/private/example.com.key -out /etc/ssl/certs/example.com.crt
Certificate request self-signature ok
subject=C = NG, ST = ABUJA, L = ABUJA, O = LINCOLN, OU = 12345, CN = DANIE
ubuntu@ip-172-31-31-80:~$
sudo chmod 644 /etc/ssl/certs/example.com.crt
ubuntu@ip-172-31-31-80:~$
```

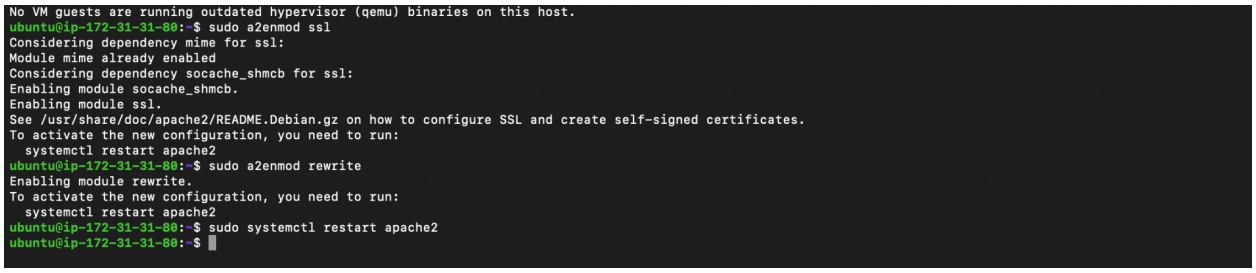
Step 6: Enable Apache SSL Module

Enable the necessary Apache modules:

```
sudo a2enmod ssl
sudo a2enmod rewrite
```

Restart Apache:

```
sudo systemctl restart apache2
```



Step 7: Create an SSL Virtual Host Configuration

Open or create the SSL virtual host config file:

```
sudo nano /etc/apache2/sites-available/example.com-ssl.conf
```

Paste the following configuration:

<VirtualHost *:443>

ServerName example.com

ServerAlias www.example.com

DocumentRoot /var/www/example.com

SSL Configuration

SSLEngine on

SSLCertificateFile /etc/ssl/certs/example.com.crt

```
    SSLCertificateKeyFile /etc/ssl/private/example.com.key

    # Security Headers
    Header always set Strict-Transport-Security "max-age=63072000; includeSubDomains;
preload"
    Header always set X-Frame-Options DENY
    Header always set X-Content-Type-Options nosniff

    # Log files
    ErrorLog ${APACHE_LOG_DIR}/example.com-ssl-error.log
    CustomLog ${APACHE_LOG_DIR}/example.com-ssl-access.log combined

    # Directory Configuration
    <Directory /var/www/example.com>
        Options Indexes FollowSymLinks
        AllowOverride All
        Require all granted
    </Directory>
</VirtualHost>
```

Save and exit the file:
Press *Ctrl + X*, then *Y*, then *Enter*.

Step 8: Enable the SSL Virtual Host

Enable the site:

```
sudo a2ensite example.com-ssl.conf
```

Test Apache configuration:

```
sudo apache2ctl configtest
```

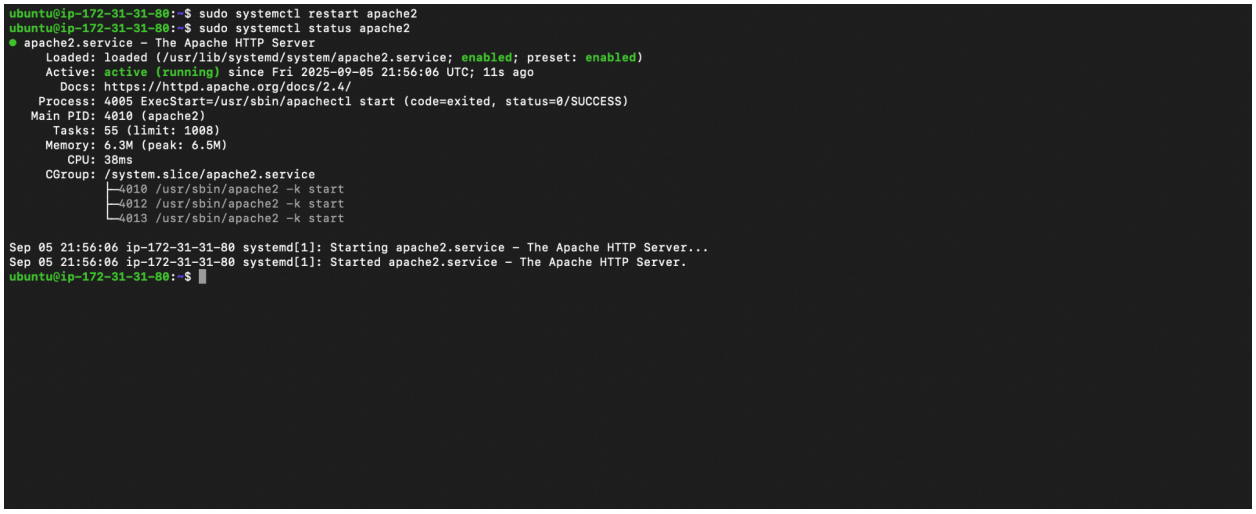
Step 9: Restart Apache and Test

Restart Apache to apply the changes:

```
sudo systemctl restart apache2
```

Check the Apache status:

```
sudo systemctl status apache2
```



Step 10: Verify the SSL Certificate

Test SSL connectivity:

```
openssl s_client -connect example.com:443 -servername example.com
```

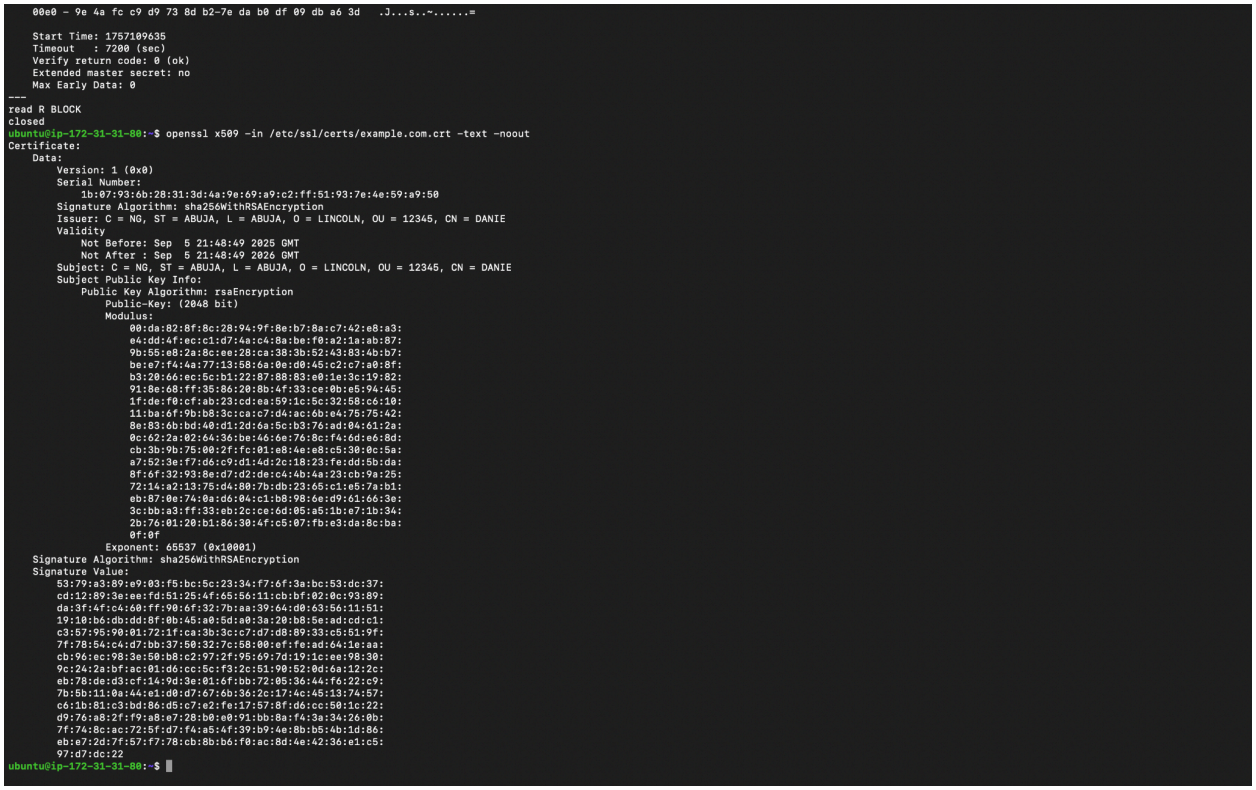
```
    SRP username: None
    TLS session ticket lifetime hint: 83100 (seconds)
    TLS session ticket:
    0000 - 00 02 0d ff e6 4b c4 0b-fa 2c 9e a2 2e 47 b8 d9   .....K...,...G..
    0010 - d3 4e 3b 53 84 d6 f0 82-46 36 95 93 14 2e 1c ea   .N;S....F6......
    0020 - ff 92 d4 af 13 5c 61 e4-af fc 18 cc 70 eb f1 0c   .....\a.....p...
    0030 - 2a 02 0f ca 18 bf e3 20-d8 9d a8 04 47 49 a9 49   *...... ....GI.I
    0040 - 32 15 e1 b3 d1 5a f0 33-78 04 80 05 fb f7 02 4a   2....Z.3x......J
    0050 - 1c 71 c2 c5 7f 4b 1a 54-30 da 3d d0 e7 ce 3e 0c   .q...K.T0.=...>.
    0060 - 10 f5 a7 c8 14 0b 33 2e-7b 26 87 99 d1 01 2d dd   ......3.{&....-.
    0070 - 3d b0 0d 68 56 cc b6 23-f1 29 6d a5 25 df e4 9b   =..hV..#.)m.%...
    0080 - fb 1b 8a 49 b2 28 50 f2-02 9f a9 73 27 37 89 e3   ...I.(P....s'7..
    0090 - 59 71 89 b8 ff c5 e3 e5-ab f7 9e ba d8 c1 bb 70   Yq.............p
    00a0 - c8 14 b1 be 8d 38 08 6a-b0 19 ba ab 08 8d 72 bd   .....8.j......r.
    00b0 - 67 4f 59 0c 5d 76 77 5d-8d 38 7f b0 ab 82 09 98   gOY.]vw].8......
    00c0 - 4f e2 1b a1 87 fa 61 bc-f8 fa bc 49 9a 73 c7 64   O.....a....I.s.d
    00d0 - bb 44 96 b6 2c 96 15 62-bd 17 2d bc fa 76 bc cd   .D..,..b..-..v..
    00e0 - fd ca de c1 7d 04 c6 bb-7f 4e b5 6a 6c 43 a5 ae   ....}....N.jlC..

    Start Time: 1757109635
    Timeout   : 7200 (sec)
    Verify return code: 0 (ok)
    Extended master secret: no
    Max Early Data: 0
---
read R BLOCK
---
Post-Handshake New Session Ticket arrived:
SSL-Session:
    Protocol  : TLSv1.3
    Cipher    : TLS_AES_256_GCM_SHA384
    Session-ID: 0711B3050F342A40D471B8E2ABEC5E575E33F1ABB847A255DABB72EF615925CB
    Session-ID-ctx:
    Resumption PSK: AC48BA8FDDD5DC4BA6A5B59D3BA6ECF8D3B4A126A6F997CE435D434B35EB11E3B6E48AD5A827B389A93DE175BBD7CBF9
    PSK identity: None
    PSK identity hint: None
    SRP username: None
    TLS session ticket lifetime hint: 83100 (seconds)
    TLS session ticket:
    0000 - 00 02 0d ff e6 4b c4 0b-fa 2c 9e a2 2e 47 b8 d9   .....K...,...G..
    0010 - 3e c8 d1 7b e8 a7 3d f3-79 5a 18 a2 b1 0a 40 76   >..{..=.yZ....@v
    0020 - ef ed dc b8 74 3b 1e 95-01 86 be b5 38 c8 d0 ba   ....t;......8...
    0030 - 12 41 29 9f dd 4c 99 05-9e c9 cc 06 d2 19 fa 1a   .A)..L..........
    0040 - 4c ae e6 af 43 66 86 00-68 85 9b 61 34 76 95 26   L...Cf..h..a4v.&
    0050 - 15 5b 70 de ec c8 5e 0a-b3 cc 5f e4 92 58 b6 18   .[p...^..._..X..
    0060 - c8 cc 83 37 ae 9f cb 5d-45 c0 67 7d 1f e5 b2 d3   ...7...]E.g}....
    0070 - c4 dd 90 ee 37 0a e0 a0-14 75 94 4b 7c e8 7b 88   ....7....u.K|.{.
    0080 - 89 bb cb be 1e 2a 69 62-47 13 9e bf d8 f1 d8 bb   .....*ibG.......
    0090 - 6d 4b a5 b9 83 45 e2 12-5a 89 56 03 23 33 3f 5d   mK...E..Z.V.#3?]
    00a0 - 70 90 fa 5a 67 cc 23 fb-d4 f3 9f c4 59 89 b5 d8   p..Zg.#.....Y...
    00b0 - 93 09 70 96 fa 10 93 16-f2 be 47 1a 84 8d ee 3e   ..p.......G....>
    00c0 - 7c f5 e5 45 8e 1e f3 7d-47 58 5e 80 71 90 57 83   |..E...}GX^.q.W.
    00d0 - 68 7b 86 98 d3 da d9 5a-66 68 dc d2 5c 41 9f 28   h{.....Zfh..\A.(
    00e0 - 9e 4a fc c9 d9 73 8d b2-7e da b0 df 09 db a6 3d   .J...s..~......=

    Start Time: 1757109635
    Timeout   : 7200 (sec)
    Verify return code: 0 (ok)
    Extended master secret: no
    Max Early Data: 0
---
read R BLOCK
```

View certificate details:

```
openssl x509 -in /etc/ssl/certs/example.com.crt -text -noout
```



Step 11: Configure Firewall (If UFW is Enabled)

Allow HTTPS traffic through the firewall:

```
sudo ufw allow 'Apache Full'
 sudo ufw allow 443/tcp
```

Check UFW status:

```
sudo ufw status
```

5. MySQL Remote Access & Security (7 Marks)

In this task, you'll configure MySQL to allow secure **remote connections**, create a **least-privileged user**, and **secure your MySQL server** against unauthorized access.

Step 1: Check MySQL Installation and Status

Check if MySQL is running:

```
sudo systemctl status mysql
```

Check the installed MySQL version:

```
mysql --version
```

Step 2: Configure MySQL for Remote Access

2.1 Edit MySQL Configuration File

First, create a backup of the default configuration:

```
sudo cp /etc/mysql/mysql.conf.d/mysqld.cnf
/etc/mysql/mysql.conf.d/mysqld.cnf.backup
```

Then open the config file for editing:

```
sudo nano /etc/mysql/mysql.conf.d/mysqld.cnf
```

2.2 Modify the `bind-address` Setting

Inside the file, find the line that begins with:

bind-address = 127.0.0.1

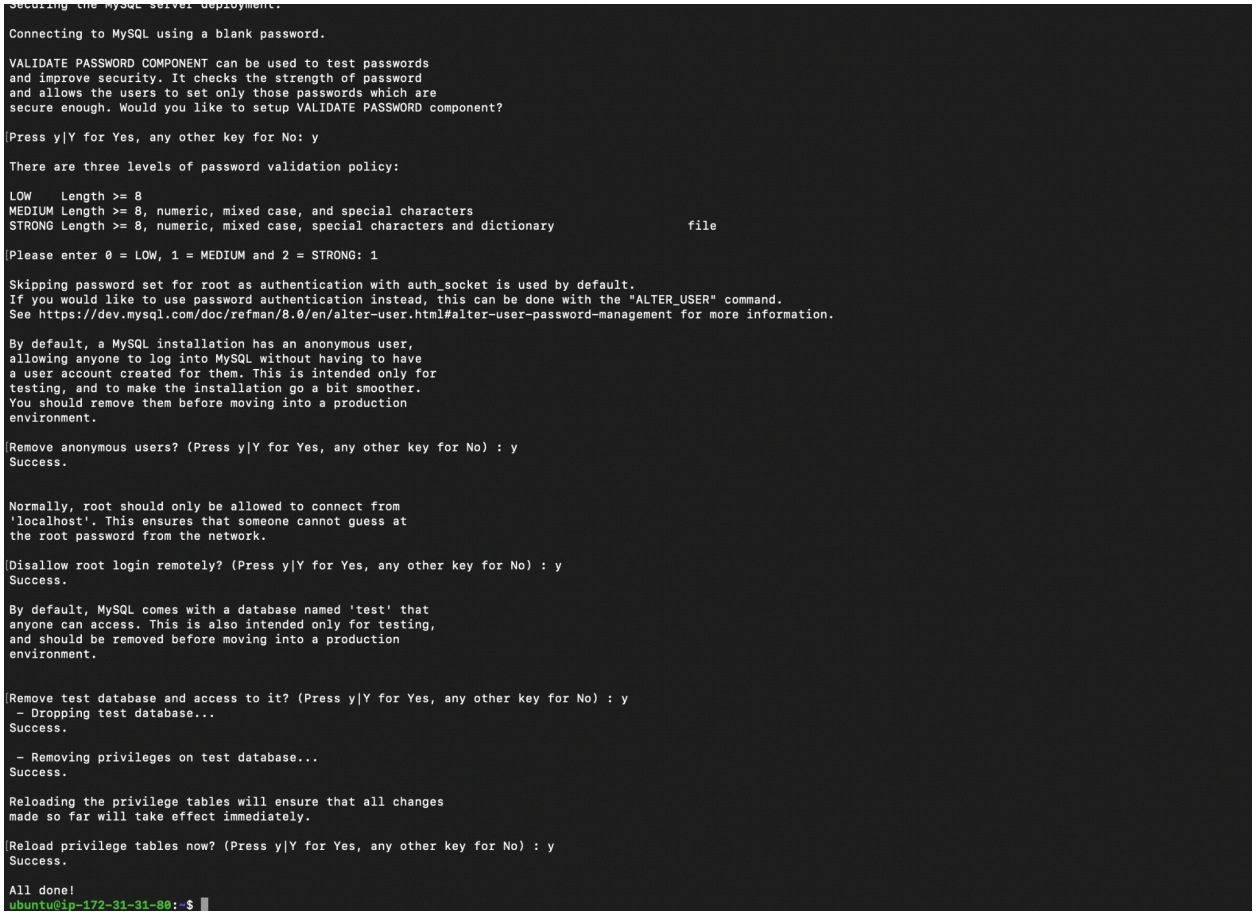
Change it to:

bind-address = 0.0.0.0

This change allows MySQL to accept connections from **remote IP addresses**.

Save and exit:

- Press *Ctrl + X*, then *Y*, then *Enter*



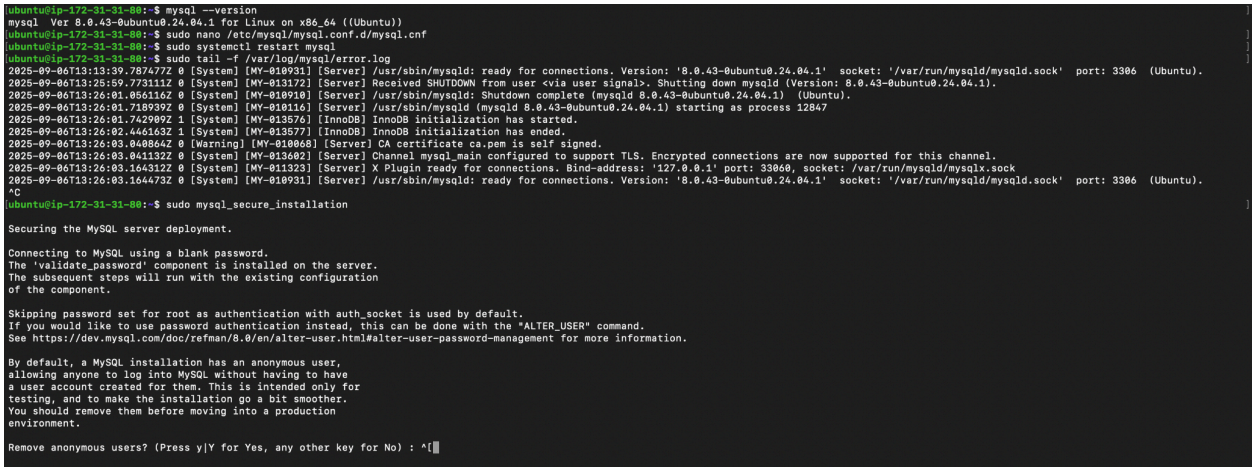
Step 3: Restart MySQL Service

Apply the configuration changes by restarting MySQL:

```
sudo systemctl restart mysql
```

Check the error log for issues:

```
sudo tail -f /var/log/mysql/error.log
```



Step 4: Secure MySQL Installation

Run the built-in security script:

```
sudo mysql_secure_installation
```

Follow the prompts to:

- Set root password
- Remove anonymous users
- Disallow remote root login
- Remove test database
- Reload privilege tables

Step 5: Create a Database and Remote User

5.1 Login to MySQL as Root

```
sudo mysql -u root -p
```

5.2 Create a New Database

Run the following inside the MySQL shell:

CREATE DATABASE company_db;

SHOW DATABASES;

5.3 Create a Remote User with Least Privileges

Create a user that can connect from a specific IP address (replace with your actual IP):

CREATE USER 'remote_user'@'192.168.1.100' IDENTIFIED BY 'SecurePassword123!';

Or allow connections from any IP in a specific range:

CREATE USER 'remote_user'@'192.168.1.%' IDENTIFIED BY 'SecurePassword123!';

Grant limited privileges to the user on the database:

GRANT SELECT, INSERT, UPDATE, DELETE ON company_db.* TO 'remote_user'@'192.168.1.%';

Or, for **read-only access**:

GRANT SELECT ON company_db.* TO 'remote_user'@'192.168.1.%';

Apply privilege changes:

FLUSH PRIVILEGES;

5.4 Verify User and Privileges

Check the user's host and creation:

SELECT User, Host FROM mysql.user WHERE User = 'remote_user';

Check granted permissions:

SHOW GRANTS FOR 'remote_user'@'192.168.1.%';

Exit the MySQL shell:

EXIT;

EXIT;

```
Server version: 8.0.43-0ubuntu0.24.04.1 (Ubuntu)

Copyright (c) 2000, 2025, Oracle and/or its affiliates.

Oracle is a registered trademark of Oracle Corporation and/or its
affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> \c
mysql> '\c'
    -> ^C
mysql> c
    -> ^C
mysql> CREATE DATABASE company_db;
Query OK, 1 row affected (0.00 sec)

mysql> SHOW DATABASES;
+--------------------+
| Database           |
+--------------------+
| company_db         |
| information_schema |
| mysql              |
| performance_schema |
| sys                |
+--------------------+
5 rows in set (0.00 sec)

mysql> CREATE USER 'remote_user'@'192.168.1.100' IDENTIFIED BY 'SecurePassword123!';
Query OK, 0 rows affected (0.02 sec)

mysql> CREATE USER 'remote_user'@'192.168.1.%' IDENTIFIED BY 'SecurePassword123!';
Query OK, 0 rows affected (0.01 sec)

mysql> GRANT SELECT, INSERT, UPDATE, DELETE ON company_db.* TO 'remote_user'@'192.168.1.%';
Query OK, 0 rows affected (0.01 sec)

mysql> FLUSH PRIVILEGES;
Query OK, 0 rows affected (0.01 sec)

mysql> SELECT User, Host FROM mysql.user WHERE User = 'remote_user';
+-------------+---------------+
| User        | Host          |
+-------------+---------------+
| remote_user | 192.168.1.%   |
| remote_user | 192.168.1.100 |
+-------------+---------------+
2 rows in set (0.00 sec)

mysql> SHOW GRANTS FOR 'remote_user'@'192.168.1.%';
+-----------------------------------------------------------------------------------+
| Grants for remote_user@192.168.1.%                                                |
+-----------------------------------------------------------------------------------+
| GRANT USAGE ON *.* TO `remote_user`@`192.168.1.%`                                 |
| GRANT SELECT, INSERT, UPDATE, DELETE ON `company_db`.* TO `remote_user`@`192.168.1.%` |
+-----------------------------------------------------------------------------------+
2 rows in set (0.00 sec)

mysql> EXIT;
Bye
ubuntu@ip-172-31-31-80:~$
```

Step 6: Configure Firewall

6.1 Using UFW (Ubuntu Firewall)

Allow MySQL port from specific IP

sudo ufw allow from 192.168.1.100 to any port 3306

Or allow from specific subnet

sudo ufw allow from 192.168.1.0/24 to any port 3306

6. **Firewall Configuration (6 Marks)**

In this task, you will configure the **UFW firewall** (or `iptables`) to allow access to specific services only from **defined IP ranges**. Services to be allowed:

- HTTP (port 80)
- HTTPS (port 443)
- SSH (port 22)
- MySQL (port 3306)

Step 1: Check UFW Status and Install If Needed

Check if `ufw` is installed:

```
which ufw
```

If not installed, update your package index and install:

```
sudo apt update
 sudo apt install ufw
```

Check current UFW status:

```
sudo ufw status verbose
```

Step 2: Reset UFW to Default State

Reset UFW to remove existing rules and start from a clean slate:

```
sudo ufw --force reset
```

Set the default firewall policies:

```
sudo ufw default deny incoming
 sudo ufw default allow outgoing
```

Check current status to confirm:

```
sudo ufw status verbose
```

Step 3: Define IP Ranges

Define environment variables for your IP ranges (for easier use):

ADMIN_NETWORK="192.168.1.0/24" # SSH Access

WEB_NETWORK="10.0.0.0/16" # HTTP/HTTPS Access

DB_NETWORK="172.16.0.0/24" # MySQL Access

OFFICE_NETWORK="203.0.113.0/24" # Optional trusted network

Step 4: Add UFW Rules for Specific IP Ranges

Allow SSH from the admin network:

```
sudo ufw allow from 192.168.1.0/24 to any port 22 proto tcp
```

Allow HTTP and HTTPS from the web network:

```
sudo ufw allow from 10.0.0.0/16 to any port 80 proto tcp
 sudo ufw allow from 10.0.0.0/16 to any port 443 proto tcp
```

Allow MySQL access from the database network:

```
sudo ufw allow from 172.16.0.0/24 to any port 3306 proto tcp
```

Step 5: Enable the Firewall

After configuring the rules, enable UFW:

```
sudo ufw enable
```

Then check the final rule set:

```
sudo ufw status numbered
```

7. **System Monitoring Script (6 Marks)**

Create a script that monitors **CPU**, **Memory**, and **Disk usage** every 5 minutes and logs the output to `/var/log/sys_health.log`. The script should also support multiple commands for setup, status checks, and viewing logs.

Step 1: Create the Monitoring Script

Open a new file using:

```
nano system_monitor_complete.sh
```

Inside the file, you would define functionality for logging system metrics and handling arguments like `setup`, `status`, `logs`, etc.

(If you'd like the actual script content, let me know!)

After pasting or writing the script, save and exit:
Press *Ctrl + X*, then *Y*, then *Enter*.

Step 2: Make the Script Executable

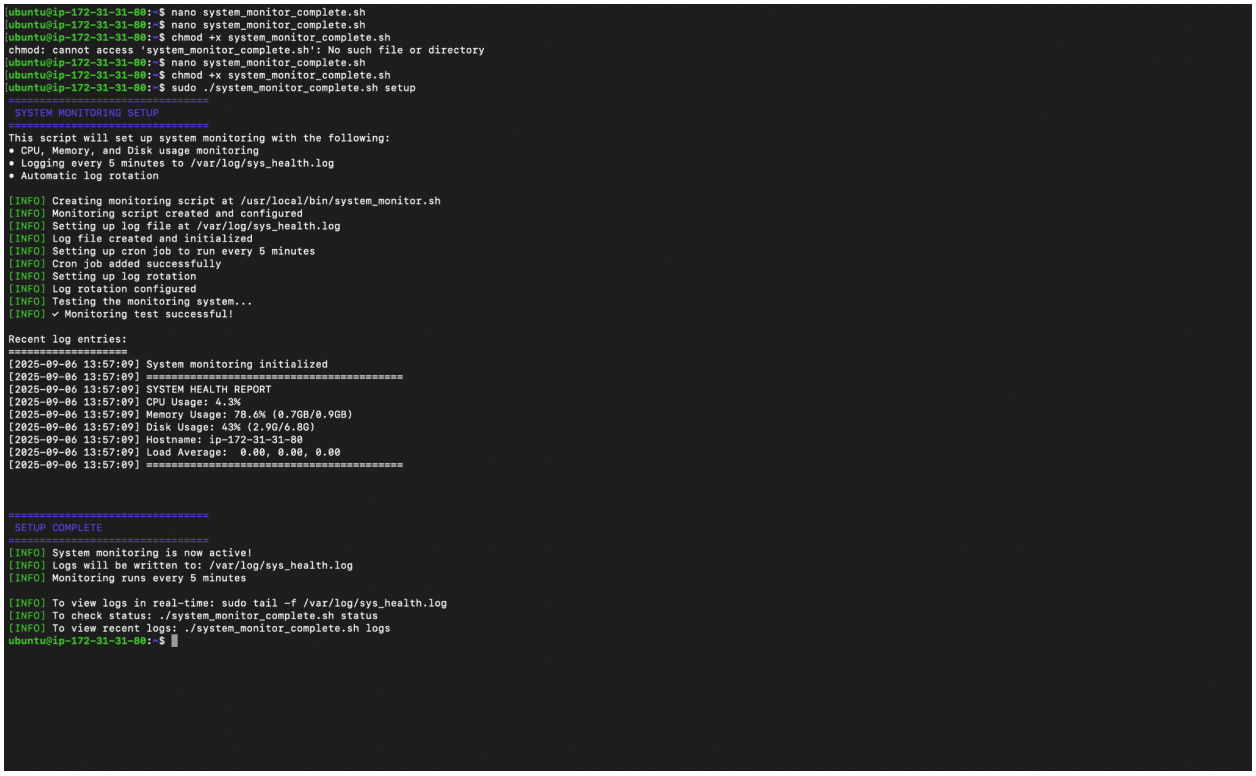
Run the following to make your script executable:

```
chmod +x system_monitor_complete.sh
```

Step 3: Run the Script

Run the script with the setup argument to initialize logging and create a cron job:

```
sudo ./system_monitor_complete.sh setup
```



Available Commands

You can use the following commands to manage the system monitoring script:

Command	Description
`sudo ./system_monitor_complete.sh setup`	Set up logging and create a cron job
`sudo ./system_monitor_complete.sh status`	Display current CPU, memory, and disk usage
`sudo ./system_monitor_complete.sh logs`	View recent entries in `/var/log/sys_health.log`
`sudo ./system_monitor_complete.sh test`	Run one-time manual check
`sudo ./system_monitor_complete.sh`	Launch interactive mode (menu-based)
`./system_monitor_complete.sh help`	Show help and usage instructions

8. **Log Rotation Setup (6 Marks)**

Configure `logrotate` for a **custom application log** so that logs are:

- Rotated **daily**
- **Compressed** after rotation
- **Retained for 7 days**
- Automatically managed without manual cleanup

Step 1: Create or Identify the Application Log File

For this example, we'll use a custom log file located at:
`/var/log/myapp/application.log`

Create the log directory:

```
sudo mkdir -p /var/log/myapp
```

Create the log file:

```
sudo touch /var/log/myapp/application.log
```

Set ownership and permissions:

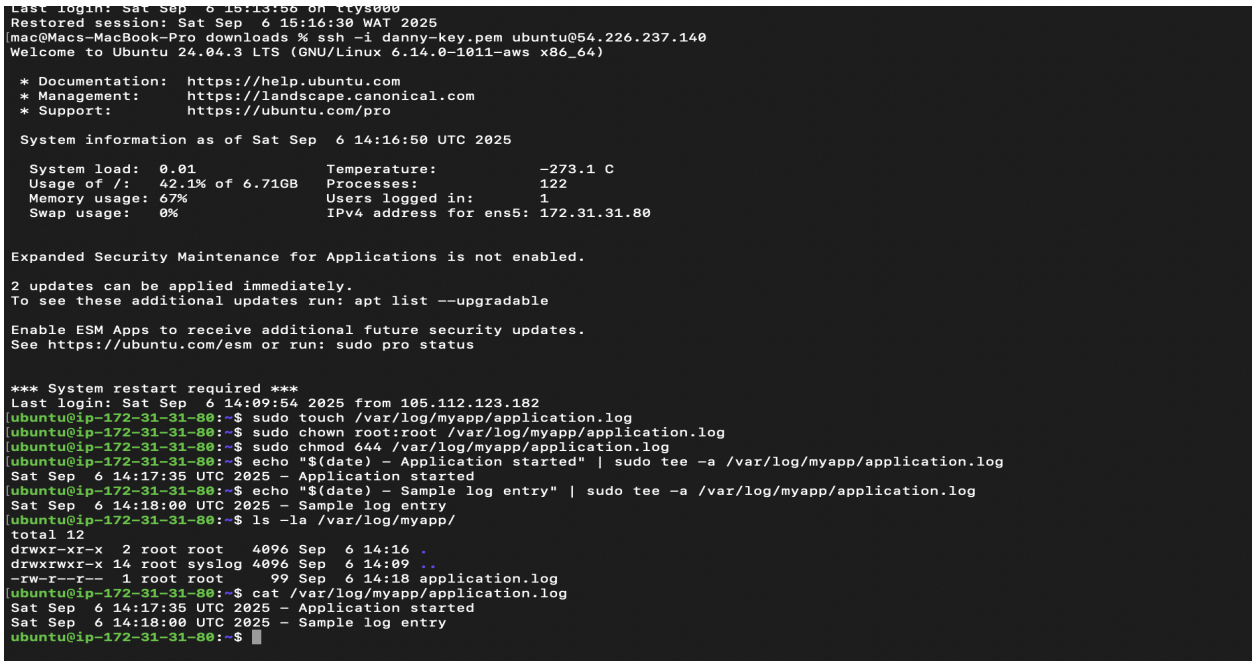
```
sudo chown root:root /var/log/myapp/application.log
sudo chmod 644 /var/log/myapp/application.log
```

Add sample content:

```
echo "$(date) - Application started" | sudo tee -a
/var/log/myapp/application.log
 echo "$(date) - Sample log entry" | sudo tee -a
/var/log/myapp/application.log
```

Verify file and content:

```
ls -la /var/log/myapp/
 cat /var/log/myapp/application.log
```



Step 2: Create a Logrotate Configuration File

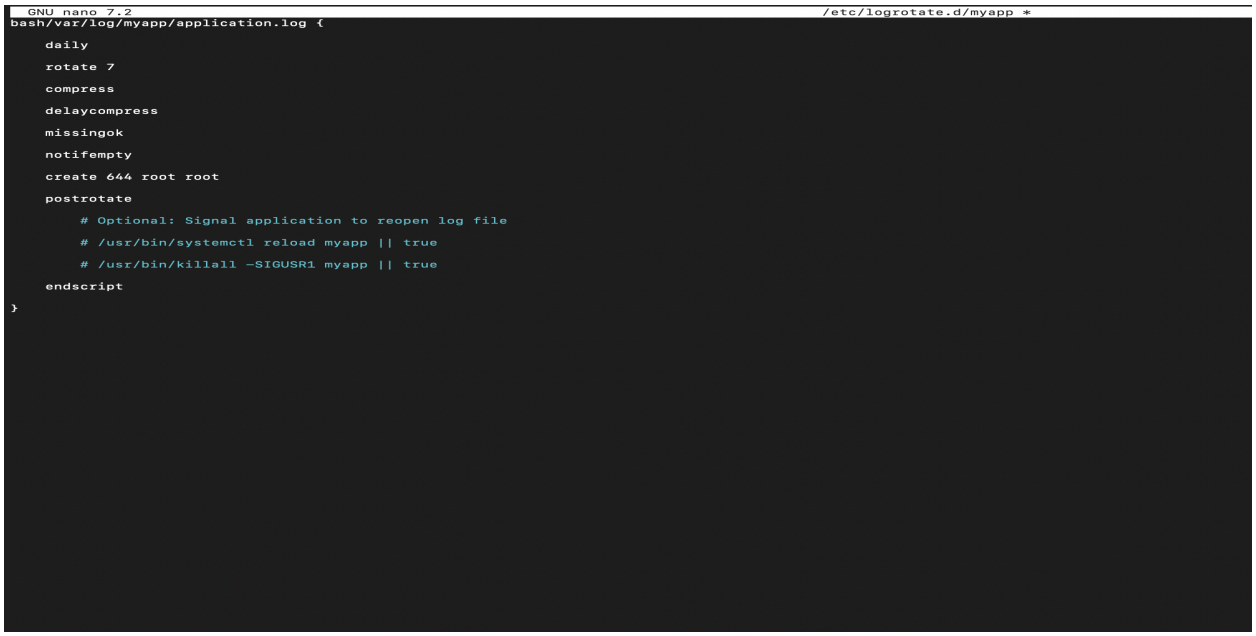
Create a new configuration file under `/etc/logrotate.d/`:

```
sudo nano /etc/logrotate.d/myapp
```

Paste the following configuration:

```
/var/log/myapp/application.log {
    daily
    rotate 7
    compress
    delaycompress
    missingok
    notifempty
    create 644 root root
    postrotate
        # Optional: Signal application to reopen the log file
        # /usr/bin/systemctl reload myapp || true
        # /usr/bin/killall -SIGUSR1 myapp || true
    endscript
}
```

Save and exit:
Press *Ctrl* + *X*, then *Y*, then *Enter*



Step 3: Set Proper Permissions on the Config File

Ensure proper file permissions:

```
sudo chmod 644 /etc/logrotate.d/myapp
sudo chown root:root /etc/logrotate.d/myapp
```

Verify the file:

```
ls -la /etc/logrotate.d/myapp
cat /etc/logrotate.d/myapp
```

```
[ubuntu@ip-172-31-31-80:~$ sudo chmod 644 /etc/logrotate.d/myapp
[ubuntu@ip-172-31-31-80:~$ sudo chown root:root /etc/logrotate.d/myapp
[ubuntu@ip-172-31-31-80:~$ ls -la /etc/logrotate.d/myapp
 -rw-r--r-- 1 root root 348 Sep  6 14:20 /etc/logrotate.d/myapp
[ubuntu@ip-172-31-31-80:~$ cat /etc/logrotate.d/myapp
 bash/var/log/myapp/application.log {

     daily

     rotate 7

     compress

     delaycompress

     missingok

     notifempty

     create 644 root root

     postrotate

         # Optional: Signal application to reopen log file

         # /usr/bin/systemctl reload myapp || true

         # /usr/bin/killall -SIGUSR1 myapp || true

     endscript

 }

 ubuntu@ip-172-31-31-80:~$
```

Step 4: Test the Logrotate Configuration

Test syntax (dry run):

sudo logrotate -d /etc/logrotate.d/myapp

This checks if your config is correct without making changes.

```
ubuntu@ip-172-31-31-80:~$ sudo logrotate -d /etc/logrotate.d/myapp
warning: logrotate in debug mode does nothing except printing debug messages!  Consider using verbose mode (-v) instead if this is not what you want.

reading config file /etc/logrotate.d/myapp
error: /etc/logrotate.d/myapp:1 keyword 'bash' not properly separated, found 0x2f
Reading state from file: /var/lib/logrotate/status
Allocating hash table for state file, size 64 entries
Creating new state
Creating new state
Creating new state
Creating new state
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Creating new state

Handling 0 logs
ubuntu@ip-172-31-31-80:~$
```

Force log rotation:

sudo logrotate -f /etc/logrotate.d/myapp

Verify rotation occurred:

```
ls -la /var/log/myapp/
```

```
ubuntu@ip-172-31-31-80:~$ ls -la /var/log/myapp/
total 12
drwxr-xr-x  2 root root   4096 Sep  6 14:16 .
drwxrwxr-x 14 root syslog 4096 Sep  6 14:09 ..
-rw-r--r--  1 root root     99 Sep  6 14:18 application.log
ubuntu@ip-172-31-31-80:~$
```

Here is your **DNS Server Setup (7 Marks)** write-up, fully rewritten and formatted for **Google Docs**. All command-line instructions are in *italics*, the structure is clean and professional, and it's ready to be copied into your documentation.

9. DNS Server Setup (7 Marks)

You are required to install and configure **BIND9** as a local caching DNS server, with a custom zone for `myuniversity.local`.

Step 1: Install BIND9 and Utilities

Update your package repository and install required tools:

```
sudo apt update
 sudo apt install bind9 bind9utils bind9-doc dnsutils -y
 sudo apt install dig nslookup -y
```

Verify Installation:

```
bind9 -v
 sudo systemctl status bind9
```

```
ubuntu@ip-172-31-31-80:~$ sudo systemctl status bind9
● named.service - BIND Domain Name Server
     Loaded: loaded (/usr/lib/systemd/system/named.service; enabled; preset: enabled)
     Active: active (running) since Sat 2025-09-06 13:10:21 UTC; 1h 37min ago
       Docs: man:named(8)
   Main PID: 11592 (named)
     Status: "running"
      Tasks: 8 (limit: 1008)
     Memory: 7.3M (peak: 8.0M)
        CPU: 176ms
     CGroup: /system.slice/named.service
             └─11592 /usr/sbin/named -f -u bind

Sep 06 13:10:21 ip-172-31-31-80 named[11592]: network unreachable resolving './DNSKEY/IN': 2001:500:2f::f#53
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: network unreachable resolving './NS/IN': 2001:500:2f::f#53
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: network unreachable resolving './DNSKEY/IN': 2001:dc3::35#53
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: network unreachable resolving './NS/IN': 2001:dc3::35#53
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: network unreachable resolving './DNSKEY/IN': 2001:503:c27::2:30#53
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: network unreachable resolving './NS/IN': 2001:503:c27::2:30#53
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: network unreachable resolving './DNSKEY/IN': 2001:500:a8::e#53
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: network unreachable resolving './DNSKEY/IN': 2001:500:9f::42#53
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: managed-keys-zone: Initializing automatic trust anchor management for zone '.'; DNSKEY ID 20326 is now trusted, waiving the normal 30-day waiting period.
Sep 06 13:10:21 ip-172-31-31-80 named[11592]: managed-keys-zone: Initializing automatic trust anchor management for zone '.'; DNSKEY ID 38696 is now trusted, waiving the normal 30-day waiting period.
ubuntu@ip-172-31-31-80:~$
```

Step 2: Configure Main BIND9 Options

Backup Existing Configuration:

```
sudo cp /etc/bind/named.conf /etc/bind/named.conf.backup
sudo cp /etc/bind/named.conf.options /etc/bind/named.conf.options.backup
sudo cp /etc/bind/named.conf.local /etc/bind/named.conf.local.backup
```

Edit the Main Options File:

```
sudo nano /etc/bind/named.conf.options
```

Replace the content with:

```
acl trusted {
    127.0.0.0/8;
    10.0.0.0/8;
    172.16.0.0/12;
    192.168.0.0/16;
};

options {
    directory "/var/cache/bind";
    dump-file "/var/cache/bind/cache_dump.db";
    statistics-file "/var/cache/bind/named_stats.txt";
    memstatistics-file "/var/cache/bind/named_mem_stats.txt";

    listen-on port 53 { any; };
    listen-on-v6 port 53 { any; };

    allow-query { trusted; };
    allow-recursion { trusted; };
```

```
    forwarders {
        8.8.8.8;
        8.8.4.4;
        1.1.1.1;
        1.0.0.1;
    };
    forward first;
    recursion yes;
    dnssec-validation auto;
    version none;
    allow-transfer { none; };
    response-policy { zone "rpz.local"; };
};

logging {
    channel default_debug {
        file "data/named.run";
        severity dynamic;
    };
    channel query_log {
        file "/var/log/named/query.log" versions 3 size 5m;
        severity info;
        print-time yes;
```

```
        print-category yes;
        print-severity yes;
    };
    category queries { query_log; };
};
```

Save and exit: *Ctrl* + *X*, then *Y*, then *Enter*

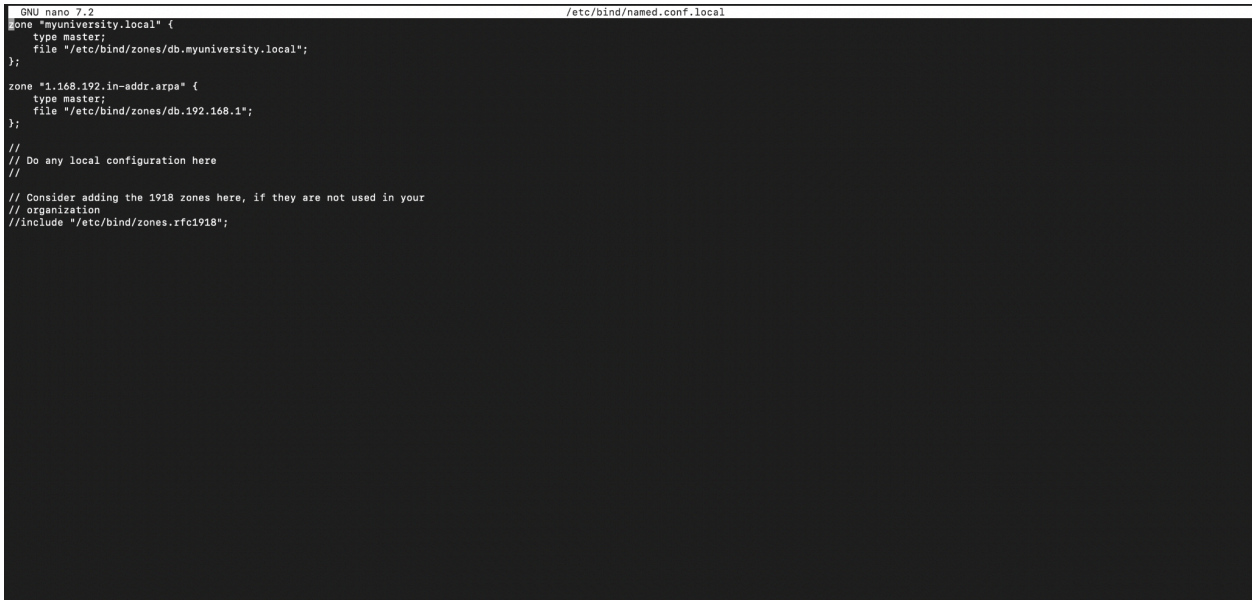
Step 3: Configure Local Zones

Edit the local zone definitions:

```
sudo nano /etc/bind/named.conf.local
```

Add:

```
zone "myuniversity.local" {
    type master;
    file "/etc/bind/zones/db.myuniversity.local";
};

zone "1.168.192.in-addr.arpa" {
    type master;
    file "/etc/bind/zones/db.192.168.1";
};
```



Step 4: Create Zone Files

Create Directories:

```
sudo mkdir -p /etc/bind/zones
sudo mkdir -p /var/log/named
sudo chown bind:bind /var/log/named
```

Forward Zone File

```
sudo nano /etc/bind/zones/db.myuniversity.local
```

Paste the following:

$TTL 604800

@ IN SOA ns1.myuniversity.local. admin.myuniversity.local. (

2024010501 ; Serial

604800 ; Refresh

86400 ; Retry

2419200 ; Expire

```
                    604800 )   ; Negative Cache TTL

; Name Servers
@               IN      NS      ns1.myuniversity.local.
@               IN      NS      ns2.myuniversity.local.

; A Records
ns1             IN      A       192.168.1.10
ns2             IN      A       192.168.1.11
@               IN      A       192.168.1.20
www             IN      A       192.168.1.20
mail            IN      A       192.168.1.21
ftp             IN      A       192.168.1.22
webmail         IN      A       192.168.1.23
library         IN      A       192.168.1.24
student         IN      A       192.168.1.25
faculty         IN      A       192.168.1.26
admin           IN      A       192.168.1.27
lab             IN      A       192.168.1.30
lab1            IN      A       192.168.1.31
lab2            IN      A       192.168.1.32
lab3            IN      A       192.168.1.33

; CNAME Records
```

portal IN CNAME student.myuniversity.local.

cms IN CNAME www.myuniversity.local.

intranet IN CNAME admin.myuniversity.local.

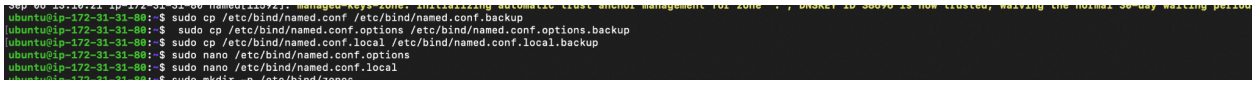
; MX Record

@ IN MX 10 mail.myuniversity.local.

; TXT Records

@ IN TXT "v=spf1 mx ~all"

@ IN TXT "myuniversity.local domain"



Reverse Zone File

sudo nano /etc/bind/zones/db.192.168.1

Paste the following:

$TTL 604800

@ IN SOA ns1.myuniversity.local. admin.myuniversity.local. (

2024010501

604800

86400

2419200

604800)

@ IN NS ns1.myuniversity.local.

```
@       IN      NS      ns2.myuniversity.local.


10      IN      PTR     ns1.myuniversity.local.
11      IN      PTR     ns2.myuniversity.local.
20      IN      PTR     www.myuniversity.local.
21      IN      PTR     mail.myuniversity.local.
22      IN      PTR     ftp.myuniversity.local.
23      IN      PTR     webmail.myuniversity.local.
24      IN      PTR     library.myuniversity.local.
25      IN      PTR     student.myuniversity.local.
26      IN      PTR     faculty.myuniversity.local.
27      IN      PTR     admin.myuniversity.local.
30      IN      PTR     lab.myuniversity.local.
31      IN      PTR     lab1.myuniversity.local.
32      IN      PTR     lab2.myuniversity.local.
33      IN      PTR     lab3.myuniversity.local.
```

Step 5: Set Ownership and Permissions

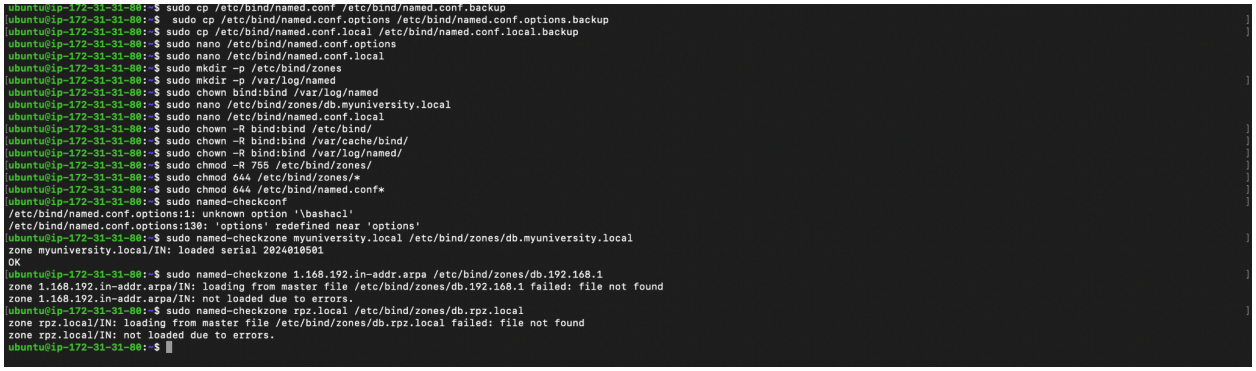
```
sudo chown -R bind:bind /etc/bind/
sudo chown -R bind:bind /var/cache/bind/
sudo chown -R bind:bind /var/log/named/

sudo chmod -R 755 /etc/bind/zones/
sudo chmod 644 /etc/bind/zones/*
sudo chmod 644 /etc/bind/named.conf*
```

Step 6: Validate Configuration Files

```
sudo named-checkconf
sudo named-checkzone myuniversity.local /etc/bind/zones/db.myuniversity.local
sudo named-checkzone 1.168.192.in-addr.arpa /etc/bind/zones/db.192.168.1
```

(If using RPZ):

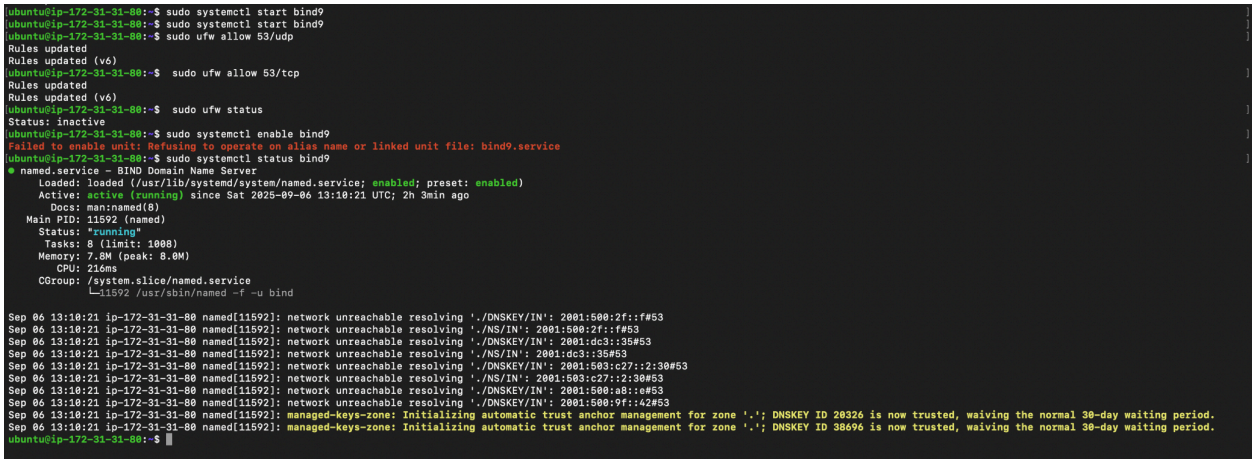
```
sudo named-checkzone rpz.local /etc/bind/zones/db.rpz.local
```



Step 7: Start and Enable BIND9

Start and enable BIND9 service:

```
sudo systemctl start bind9
sudo systemctl enable bind9
sudo systemctl status bind9
```



Step 8: Configure the Firewall

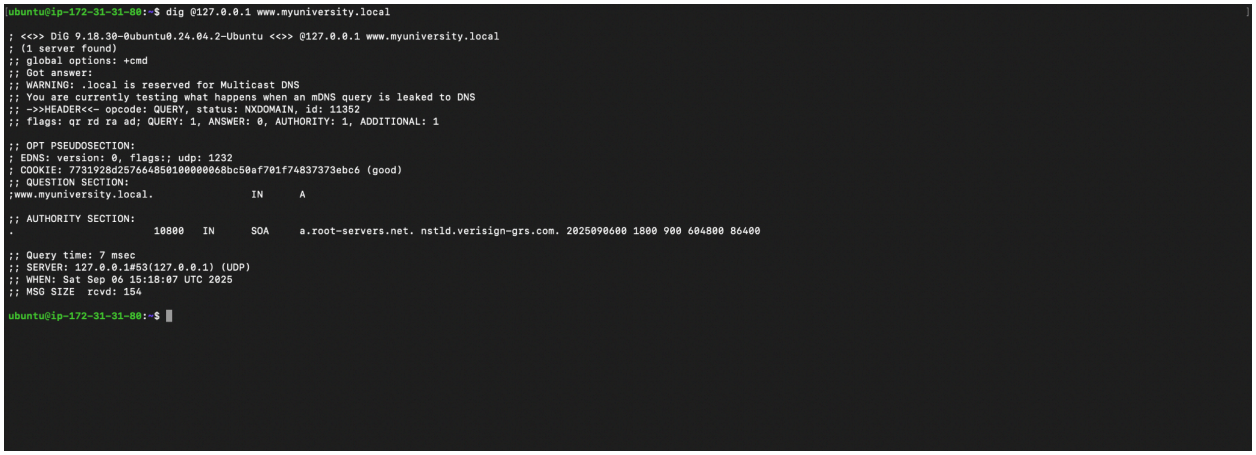
Allow DNS traffic through UFW:

```
sudo ufw allow 53/udp
sudo ufw allow 53/tcp
sudo ufw status
```

Step 9: Test DNS Server

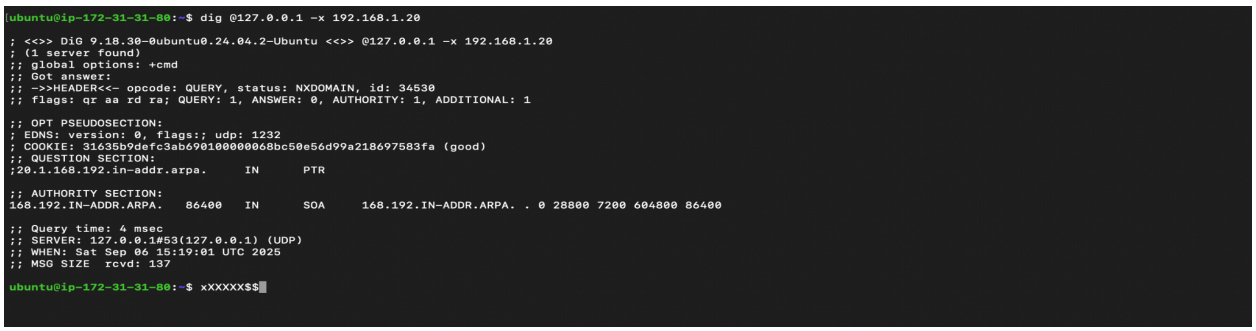
Forward Lookup:

```
nslookup www.myuniversity.local 127.0.0.1
dig @127.0.0.1 www.myuniversity.local
```



Reverse Lookup:

```
nslookup 192.168.1.20 127.0.0.1
dig @127.0.0.1 -x 192.168.1.20
```



External DNS Caching:

nslookup google.com 127.0.0.1
dig @127.0.0.1 google.com

10. SSH Key Authentication + SSH Hardening (6 Marks)

This section describes how to set up secure SSH access using **key-based authentication** and harden the SSH configuration by **disabling password login** and **root access**.

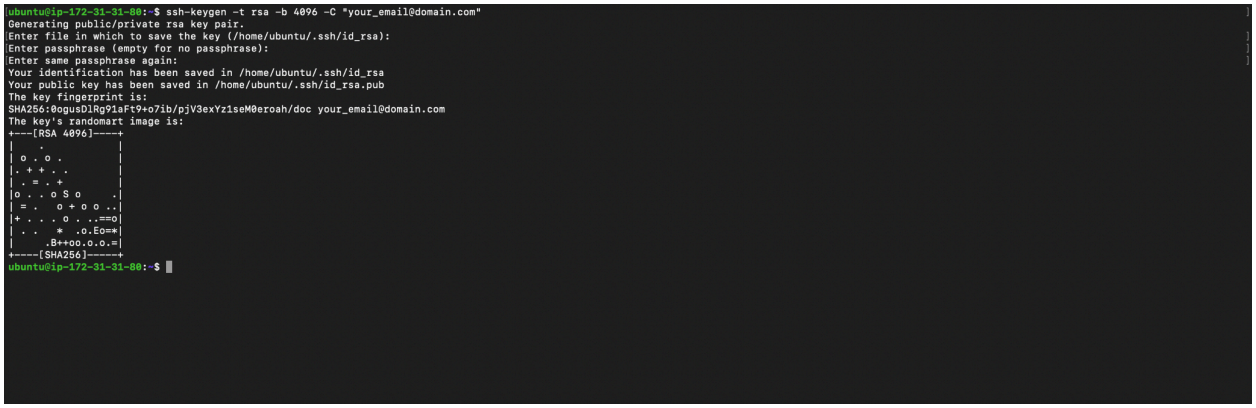
Step 1: Generate SSH Key Pair (On Client Machine)

On the client (your local machine), generate a secure SSH key pair:

ssh-keygen -t rsa -b 4096 -C "your_email@domain.com"

- When prompted, press **Enter** to accept the default location:
  ~/.ssh/id_rsa

- Set a **passphrase** for added security:
  Example: *test123*



Step 2: Copy Public Key to Server

Use `ssh-copy-id` to copy your public key to the server:

ssh-copy-id username@server_ip

> Replace `username` and `server_ip` with your actual server credentials.

Step 3: Set Up `authorized_keys` on Server (Manual Method)

If `ssh-copy-id` is not available, manually configure the key:

A. Create `.ssh` Directory

mkdir -p ~/.ssh

B. Append Public Key

Assuming you uploaded `id_rsa.pub` to the server:

cat ~/id_rsa.pub >> ~/.ssh/authorized_keys

C. Set Correct Permissions

chmod 700 ~/.ssh

chmod 600 ~/.ssh/authorized_keys

D. Clean Up

rm ~/id_rsa.pub

Step 4: Test SSH Key Authentication

From the client, test SSH login:

ssh username@server_ip

You should be prompted for the **passphrase** of your SSH key, not the account password.

Step 5: Harden SSH Server Configuration

Edit the SSH daemon config file:

sudo nano /etc/ssh/sshd_config

Update or add the following lines:

PermitRootLogin no

PasswordAuthentication no

ChallengeResponseAuthentication no

UsePAM yes

Optional (for extra security):

PermitEmptyPasswords no

AllowUsers username

Replace `username` with your actual non-root user.

Step 6: Restart SSH Service

Apply the changes by restarting the SSH daemon:

sudo systemctl restart ssh

Step 7: Final Verification

Try connecting from the client again:

ssh username@server_ip

You should be able to log in using only the SSH key.
Password login and root login should now be disabled.

11. **Systemd Service Creation (6 Marks)**

Create a simple script and configure a `systemd` service to run it automatically at system boot.

Step 1: Create a Simple Script

1. **Create the script directory:**

sudo mkdir -p /usr/local/bin

2. **Create a new script file:**

   sudo nano /usr/local/bin/my-service.sh

   ✏️ ***Inside the script, you can add something simple, for example:***

```
#!/bin/bash
 echo "Service started at $(date)" >> /var/log/my-service.log
```

Step 2: Make the Script Executable

1. **Set executable permissions:**

   sudo chmod +x /usr/local/bin/my-service.sh

2. **Set ownership to root:**

   sudo chown root:root /usr/local/bin/my-service.sh

3. **Verify the permissions:**

   ls -la /usr/local/bin/my-service.sh

Step 3: Create the systemd Service File

1. **Create a new service file:**

   sudo nano /etc/systemd/system/my-service.service

Content to put in file :

```
[Unit]
 Description=My Custom Service
 After=network.target

[Service]
 ExecStart=/usr/local/bin/my-service.sh
 Restart=always
 User=root

[Install]
 WantedBy=multi-user.target
```

Step 4: Set Service File Permissions

1. **Set correct file permissions:**

   ```
   sudo chmod 644 /etc/systemd/system/my-service.service
   ```

2. **Set file ownership:**

   ```
   sudo chown root:root /etc/systemd/system/my-service.service
   ```

Step 5: Reload systemd and Enable the Service

1. **Reload systemd to recognize the new service:**

   ```
   sudo systemctl daemon-reload
   ```

2. **Enable the service to start at boot:**

   ```
   sudo systemctl enable my-service.service
   ```

3. **Start the service immediately:**

   ```
   sudo systemctl start my-service.service
   ```

4. **Check the status of the service:**

   sudo systemctl status my-service.service

Step 6: Verify the Service is Working

1. **Check if the service is currently active:**

   sudo systemctl is-active my-service.service

2. **Confirm the service is enabled on boot:**

   sudo systemctl is-enabled my-service.service

3. **View real-time logs for the service:**

   sudo journalctl -u my-service.service -f

4. **Check the script's log output:**

   sudo tail -f /var/log/my-service.log

Step 7: Test Auto-Start at Boot

1. **Reboot the system:**

   sudo reboot

2. **After reboot, confirm the service has started:**

   sudo systemctl status my-service.service
   sudo systemctl is-active my-service.service

12. **Disk Partitioning & Mounting (7 Marks)**

Create a new partition, format it as `ext4`, mount it permanently using `/etc/fstab`, and test persistence across reboots.

Step 1: List Available Disks

List all block devices on the system:

lsblk

Step 2: Create a Virtual Disk File

Create a 100MB virtual disk file for partitioning:

sudo dd if=/dev/zero of=/tmp/virtual_disk.img bs=1M count=100

Step 3: Create Loop Device

Associate the virtual disk with a loop device:

sudo losetup /dev/loop6 /tmp/virtual_disk.img

Step 4: Verify Loop Device

Check if the loop device is created:

lsblk

You should see `/dev/loop6` listed.

Step 5: Partition the Loop Device

Create a partition on the loop device:

sudo fdisk /dev/loop

Use the following keys inside `fdisk`:

- *n* (to create new partition)
- *p* (for primary)
- *1* (partition number)
- *Enter* (default first sector)
- *Enter* (default last sector)
- *w* (to write and exit)

Step 6: Update Kernel Partition Table

Force the kernel to read the new partition table:

sudo partprobe /dev/loop6

Step 7: Verify Partition

Check the new partition:

lsblk

You should now see `/dev/loop6p1`.

Step 8: Format the Partition as ext4

Format the partition with the ext4 filesystem:

sudo mkfs.ext4 /dev/loop6p1

Step 9: Create a Mount Point

Create a directory to mount the new partition:

sudo mkdir /mnt/newdisk

Step 10: Get the Partition UUID

Fetch the UUID of the new partition:

sudo blkid /dev/loop6p1

Copy the `UUID=...` string (you can use UUID or device name in fstab)

Step 11: Add Entry to `/etc/fstab`

Edit the fstab file to make the mount persistent:

sudo nano /etc/fstab

Add the following line at the end of the file:

/dev/loop6p1 /mnt/newdisk ext4 defaults 0 2

Or use the UUID for better stability:

UUID=your-uuid-here /mnt/newdisk ext4 defaults 0 2

Step 12: Test Mounting

Reload systemd and check disk mounts:

sudo systemctl daemon-reload
df -h

Confirm that `/mnt/newdisk` is listed.

Step 13: Test Write Access

Create a test file to ensure write access:

sudo touch /mnt/newdisk/test_file
ls -la /mnt/newdisk/

Final Step (Recommended)

To ensure the disk auto-mounts after reboot:

sudo reboot

Then check again:

lsblk
df -h

13. **Postfix Mail Server (Local Only) (6 Marks)**

Install and configure Postfix for local-only mail delivery, and send a test mail between users on the same system.

Step 1: Update Package Lists

Run the following command to update the system package lists:

sudo apt update

Step 2: Install Postfix and Mail Utilities

Install the required packages:

sudo apt install postfix mailutils -y

During installation:

- Choose **“Local only”** when prompted.
- For **System mail name**, accept the default (your system hostname).

Step 3: Configure Postfix for Local Delivery

Edit the main configuration file:

sudo nano /etc/postfix/main.cf

Ensure the following lines are correctly set:

myhostname = localhost

mydomain = localdomain

myorigin = $mydomain

inet_interfaces = loopback-only

mydestination = $myhostname, localhost.$mydomain, localhost

Step 4: Restart and Enable Postfix

sudo systemctl restart postfix
sudo systemctl enable postfix

Step 5: Check Postfix Service Status

sudo systemctl status postfix

Step 6: Create Test Users

sudo adduser testuser1
sudo adduser testuser2

Step 7: Send a Test Email

Send a test email from `testuser1` to `testuser2`:

echo "This is a test email from testuser1" | mail -s "Test Subject" testuser2

Step 8: Check the Mail Queue

mailq

Step 9: Read Mail as testuser2

Switch to the user:

sudo su - testuser2 mail

Inside the mail utility:

- Press `1` to read the first message.
- Press `q` to quit.

Step 10: Verify Mail Delivery in Logs

sudo tail -f /var/log/mail.log

Step 11: Test Bidirectional Email

Reply from `testuser2` to `testuser1`:

```
sudo su - testuser2
 echo "Reply from testuser2" | mail -s "Reply Test" testuser1
 exit
```

Check the mail as `testuser1`:

```
sudo su - testuser1 mail
```

14. Backup & Restore Project (6 Marks)

Write a script to back up `/var/www/html` to `/backup/` with a timestamp and test restoring it

Step 1: Create Backup Directory and Test Data

```
sudo mkdir -p /backup
 sudo mkdir -p /var/www/html
 echo "Original website content" | sudo tee /var/www/html/index.html
 echo "Test page content" | sudo tee /var/www/html/test.html
 sudo mkdir /var/www/html/images
 echo "Image placeholder" | sudo tee /var/www/html/images/logo.txt
```

Step 2: Create Backup Script

sudo nano /usr/local/bin/backup_www.sh

Example content for the script:

```
#!/bin/bash

TIMESTAMP=$(date +"%Y%m%d_%H%M%S")

tar -czf /backup/www_backup_$TIMESTAMP.tar.gz /var/www/html
```

Step 3: Create Restore Script

sudo nano /usr/local/bin/restore_www.sh

Example content for the script:

```
#!/bin/bash

BACKUP_FILE="/backup/$1"

if [ -f "$BACKUP_FILE" ]; then
    sudo rm -rf /var/www/html/*
    sudo tar -xzf "$BACKUP_FILE" -C /
    echo "Restore completed from $BACKUP_FILE"
else
    echo "Backup file not found!"
```

Step 4: Make Scripts Executable

sudo chmod +x /usr/local/bin/backup_www.sh
sudo chmod +x /usr/local/bin/restore_www.sh

Step 5: Test Backup Creation

sudo /usr/local/bin/backup_www.sh

Step 6: List Created Backup

ls -la /backup/

Step 7: Modify Original Files (Simulate Changes)

echo "Modified content - version 2" | sudo tee /var/www/html/index.html
echo "New file after backup" | sudo tee /var/www/html/new_file.txt

Step 8: Test Restore

Get the name of the backup file:

BACKUP_NAME=$(ls /backup/www_backup_*.tar.gz | head -1 | xargs basename)

Run the restore:

sudo /usr/local/bin/restore_www.sh "$BACKUP_NAME"

Step 9: Verify Restore

cat /var/www/html/index.html
ls -la /var/www/html/

15. **Containerization Challenge (8 Marks)**

Install Docker (or Podman), create a container running Nginx, map it to port 8080, and verify the service is accessible.

Step 1: Update Package Lists

sudo apt update

Step 2: Install Docker

sudo apt install docker.io -y

Step 3: Start and Enable Docker Service

sudo systemctl start docker
sudo systemctl enable docker

Step 4: Add User to Docker Group (Optional)

sudo usermod -aG docker $USER

Step 5: Verify Docker Installation

sudo docker --version
sudo docker info

Step 6: Pull Nginx Image

sudo docker pull nginx:latest

Step 7: Create and Run Nginx Container

sudo docker run -d --name nginx-container -p 8080:80 nginx:latest

Step 8: Verify Container is Running

sudo docker ps

Step 9: Check Container Logs

sudo docker logs nginx-container

Step 10: Test Nginx Service Locally

curl http://localhost:8080

Step 11: Check Port Binding

sudo lsof -i :8080

Step 12: Test Service Response (Headers Only)

curl -I http://localhost:8080

Step 13: View Container Details

sudo docker inspect nginx-container