

- task2_echoes_all.png

```
nayab046@nayab046:~$ export DB_PASSWORD=labpass123
nayab046@nayab046:~$ echo "$DB_URL"
postgres://db.example.local:5432/mydb
nayab046@nayab046:~$ echo "$DB_USER"
labuser
nayab046@nayab046:~$ echo "$DB_PASSWORD"
labpass123
nayab046@nayab046:~$ |
```

- task2_printenv_grep_db.png

```
nayab046@nayab046:~$ printenv | grep '^DB_'
DB_PASSWORD=labpass123
DB_USER=labuser
DB_URL=postgres://db.example.local:5432/mydb
nayab046@nayab046:~$ |
```

- task2_after_restart_checks.png

```
nayab046@nayab046:~$ echo "$DB_URL"
postgres://db.example.local:5432/mydb
nayab046@nayab046:~$ printenv | grep '^DB_'
DB_PASSWORD=labpass123
DB_USER=labuser
DB_URL=postgres://db.example.local:5432/mydb
nayab046@nayab046:~$ |
```

Task 3 — Make DB_* variables persistent in ~/.bashrc

- task3_bashrc_added.png

```
# add at the end:
# Lab 7 persistent DB variables
export DB_URL="postgres://db.example.local:5432/mydb"
export DB_USER="labuser"
export DB_PASSWORD="labpass123"
```

- task3_source_and_verification.png

```
nayab046@nayab046:~$ source ~/.bashrc
nayab046@nayab046:~$ echo "$DB_URL"
postgres://db.example.local:5432/mydb
nayab046@nayab046:~$ echo "$DB_USER"
labuser
nayab046@nayab046:~$ echo "$DB_PASSWORD"
labpass123
nayab046@nayab046:~$ printenv | grep '^DB_'
DB_PASSWORD=labpass123
DB_USER=labuser
DB_URL=postgres://db.example.local:5432/mydb
nayab046@nayab046:~$ |
```

- task3_after_restart_persistent.png

```
nayab046@nayab046:~$ echo "$DB_URL"
postgres://db.example.local:5432/mydb
nayab046@nayab046:~$ printenv | grep '^DB_'
DB_PASSWORD=labpass123
DB_USER=labuser
DB_URL=postgres://db.example.local:5432/mydb
nayab046@nayab046:~$ |
```

Task 4 — System-wide environment variable, welcome script, and PATH

- task4_etc_environment_before.png

```
nayab046@nayab046:~$ sudo cat /etc/environment
[sudo] password for nayab046:
PATH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin"
nayab046@nayab046:~$ |
```

- task4_echo_path_before.png

```
nayab046@nayab046:~$ echo "$PATH"
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
nayab046@nayab046:~$ |
```

- task4_etc_environment_edit_vim.png

```
PATH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin"
# add line: Class="CC-BSE-5B"
~
```

- task4_etc_environment_after.png

```
nayab046@nayab046:~$ cat /etc/environment
PATH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin"
class="CC-BSE-5B"
nayab046@nayab046:~$ |
```

- task4_echo_class_and_path.png

```
nayab046@nayab046:~$ echo $Class
nayab046@nayab046:~$ echo "$PATH"
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
nayab046@nayab046:~$ |
```

- task4_welcome_create_and_chmod.png

```
nayab046@nayab046:~$ cat > ~/welcome <<'EOF'
#!/bin/bash
echo "Welcome to Cloud Computing $USER"
EOF
nayab046@nayab046:~$ chmod +x ~/welcome
nayab046@nayab046:~$ |
```

- task4_welcome_run_dot.png

```
nayab046@nayab046:~$ cd ~
nayab046@nayab046:~$ ./welcome
Welcome to Cloud Computing nayab046
nayab046@nayab046:~$ |
```

- task4_bashrc_path_line.png

```
PATH=$PATH:~/Desktop
export PATH
PATH=$PATH:~
~
```

- task4_bashrc_source_and_welcome.png

```
nayab046@nayab046:~$ source ~/.bashrc
nayab046@nayab046:~$ cd ~
nayab046@nayab046:~$ welcome
```

Task 5 — Block and allow SSH using ufw

- task5_ufw_enable_and_status.png

```
nayab046@nayab046:~$ sudo ufw enable
[sudo] password for nayab046:
Firewall is active and enabled on system startup
nayab046@nayab046:~$ sudo ufw status verbose
Status: active
Logging: on (low)
Default: deny (incoming), allow (outgoing), disabled (routed)
New profiles: skip
nayab046@nayab046:~$ _
```

- task5_ufw_deny_22_and_status.png

```
nayab046@nayab046:~$ sudo ufw deny 22/tcp
Rule added
Rule added (v6)
nayab046@nayab046:~$ sudo ufw status numbered
Status: active

    To Action From
    --
[ 1] 22/tcp DENY IN Anywhere
[ 2] 22/tcp (v6) DENY IN Anywhere (v6)

nayab046@nayab046:~$
```

- task5_ssh_attempt_blocked.png

```
nayab046@nayab046:~$ ssh nayab046@192.168.254.131
nayab046@192.168.254.131's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-71-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/pro

System information as of Mon Nov 24 01:42:38 PM UTC 2025

System load:  0.02          Processes:      226
Usage of /:   56.9% of 9.75GB Users logged in:   1
Memory usage: 15%          IPv4 address for ens33: 192.168.254.131
Swap usage:   0%

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.
   https://ubuntu.com/engage/secure-kubernetes-at-the-edge

Expanded Security Maintenance for Applications is not enabled.

74 updates can be applied immediately.
38 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

The list of available updates is more than a week old.
To check for new updates run: sudo apt update

Last login: Mon Nov 24 12:52:35 2025 from 192.168.254.1
nayab046@nayab046:~$ _
```

- task5_ufw_allow_reload_status.png

```
nayab046@nayab046:~$ sudo ufw allow 22/tcp
[sudo] password for nayab046:
Rule updated
Rule updated (v6)
nayab046@nayab046:~$ sudo ufw reload
Firewall reloaded
nayab046@nayab046:~$ sudo ufw status
Status: active

To Action From
--
22/tcp ALLOW Anywhere
22/tcp (v6) ALLOW Anywhere (v6)

nayab046@nayab046:~$ _
```

- task5_ssh_success_after_allow.png

```
nayab046@nayab046:~$ ssh nayab046@192.168.254.131
nayab046@192.168.254.131's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-71-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/pro

System information as of Mon Nov 24 01:46:40 PM UTC 2025

System load:  0.0          Processes:      232
Usage of /:   56.9% of 9.75GB Users logged in: 1
Memory usage: 16%         IPv4 address for ens33: 192.168.254.131
Swap usage:   0%

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

   https://ubuntu.com/engage/secure-kubernetes-at-the-edge

Expanded Security Maintenance for Applications is not enabled.

74 updates can be applied immediately.
38 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

The list of available updates is more than a week old.
To check for new updates run: sudo apt update

Last login: Mon Nov 24 13:42:39 2025 from 192.168.254.131
nayab046@nayab046:~$
```

Task 6 — Configure SSH key-based login from Windows host

- task6_windows_sshkey_and_list.png

```

Enter same passphrase again:
Your identification has been saved in C:\Users\Laptop\.ssh\id_lab7
Your public key has been saved in C:\Users\Laptop\.ssh\id_lab7.pub
The key fingerprint is:
SHA256:ch1DY033WkaOrDurLd1MZ8NH09wLUOKVim382X9dJEY lab_key
The key's randomart image is:
+--[ED25519 256]--+
|    oo. ooo. |
|    . ... oE . |
|    .o+.o o+ |
|    .oo* +.* |
|    . S .+ 0 *.|
|    o   + % + |
|    . = * o+ |
|    ..+ +   + |
|    .o++   . |
+-----[SHA256]-----+

C:\Users\Laptop>ls -la ~/.ssh
'ls' is not recognized as an internal or external command,
operable program or batch file.

C:\Users\Laptop>dir %USERPROFILE%\\.ssh
Volume in drive C has no label.
Volume Serial Number is ACD8-A7BE

Directory of C:\Users\Laptop\.ssh

11/07/2025  10:14 AM    <DIR>          .
11/07/2025  10:14 AM    <DIR>          ..
09/27/2025  02:07 PM                419 id_ed25519
09/27/2025  02:07 PM                110 id_ed25519.pub
11/07/2025  10:14 AM                399 id_lab7
11/07/2025  10:14 AM                90 id_lab7.pub
10/24/2025  09:33 AM               1,674 known_hosts
10/24/2025  09:33 AM                925 known_hosts.old
               6 File(s)                3,617 bytes
               2 Dir(s)              6,718,468,096 bytes free

```

```
C:\Users\Laptop>type %USERPROFILE%\ssh\id_lab7.pub
ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAAAIG/sAac1jNtpG8Q9t5IU/ToadwALXwViz2VUJ0cRgQZ3 lab_key
C:\Users\Laptop>
```

```
C:\Users\Laptop>echo "" > %USERPROFILE%\\.ssh\known_hosts
C:\Users\Laptop>type %USERPROFILE%\\.ssh\known_hosts
""
```

```
ED25519 key fingerprint is SHA256:rrrwoC97Xj50JGM0ciBh4uffKm0pGj/sTKCaf6Q0cDE.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.56.135' (ED25519) to the list of known hosts.
safa@192.168.56.135's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-86-generic x86_64)

* Documentation:  https://help.ubuntu.com
* Management:    https://landscape.canonical.com
* Support:       https://ubuntu.com/pro
```

```
ZUSERPROFILE%>.ssh\known_hosts
```

```
25519 AAAAC3NzaC1lZDI0NTU5AAAAIQ08/sDuVjbD3Lix/7JYHDSNmVtcI6RfS+yBHE/Vuhva  
a AAAAB3NzaC1yc2EAAAADAQABAAQCAAGCcTzFf68jWnShvbfEebt35F3KQlWmTmjxgllKHFDw4pxct3pjrtzjh7ehzmzxzr4zoTbb4UysRdu+EHnlZ5Asrg5Lm803159uDWMVnpnggieAwkIDCSFytc  
WqJkfBdG80pLsgE5HtpTrRya//i1NsK5pG+Cxequdf0vAwxzd2TE6K3cjddjn3SeelqrT/pjyilWmSX19ZYeOKgg/eY1TuXc3eSFUPQK10joEF+Thn54FjG0hv1e9bUsXqFqgb00EG6GLmh0bj  
ciierCPge2Z4qgibDFdzFgmHRYZMnm8KtYten+ht1Ya8Enk/MmvOGKOptqx4FPuu4OXBEwUSOxeCS5p9Zkb5SEhePuHTqjTV8+f88glUKS2KkjvJupIm  
sha2-nistp256 AAAAEZWNhbnRlcNoTiYtblmLzhAYnIAAAAAIbmLzdhAYNTAAABBBHoxhtHj9AG6B4+j1ZangSHy/Ndg6j1TWmcTqtZtlVLccdg7GmELP1Ex8xmPinIEtQEUFryRSufUGDPQRQhGtpvaal=
```

- task6_server_clear_authorized_keys.png

```
nayab046@nayab046:~$ mkdir -p ~/.ssh
nayab046@nayab046:~$ chmod 700 ~/.ssh
nayab046@nayab046:~$ > ~/.ssh/authorized_keys
nayab046@nayab046:~$ _
```

- task6_ssh_with_identity_file.png

```
nayab046@nayab046:~$ echo "ssh-ed25519 AAAA... yourpublickey ... comment" >>
~/.ssh/authorized_keys
nayab046@nayab046:~$ chmod 600 ~/.ssh/authorized_keys
nayab046@nayab046:~$ cat ~/.ssh/authorized_keys
ssh-ed25519 AAAA... yourpublickey ... comment
nayab046@nayab046:~$
```

- task6_ssh_passwordless_login.png

```
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-86-generic x86_64)

* Documentation:  https://help.ubuntu.com
* Management:    https://landscape.canonical.com
* Support:       https://ubuntu.com/pro

System information as of Fri Nov  7 05:36:54 AM UTC 2025

System load:  0.0          Processes:      230
Usage of /:   88.2% of 9.75GB Users logged in:    1
Memory usage: 8%          IPv4 address for ens33: 192.168.56.135
Swap usage:   0%

=> / is using 88.2% of 9.75GB

Expanded Security Maintenance for Applications is not enabled.
```

- task6_ssh_with_identity_file.png

```
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-86-generic x86_64)

* Documentation:  https://help.ubuntu.com
* Management:    https://landscape.canonical.com
* Support:       https://ubuntu.com/pro
```

Exam Evaluation Questions

Q1: Quick Environment Audit

EE_q1_env_all.png

```
nayab046@nayab046:~$ printenv
SHELL=/bin/bash
PWD=/home/nayab046
LOGNAME=nayab046
XDG_SESSION_TYPE=ttty
HOME=/home/nayab046
LANG=en_US.UTF-8
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=40;33;01:or=40;31;01:mi=00:su=37;41:sg=30;43:ca=00:tw=30;42:ow=34;42:st=37;44:ex=01;32:*tar=01;31:*arc=01;31:*arj=01;31:*taz=01;31:*lha=01;31:*lzh=01;31:*lma=01;31:*tlz=01;31:*ttx=01;31:*tzo=01;31:*t7z=01;31:*zip=01;31:*z=01;31:*dj=01;31:*gz=01;31:*lrr=01;31:*lz=01;31:*lzo=01;31:*xz=01;31:*zst=01;31:*tztst=01;31:*bz2=01;31:*bz=01;31:*tbz=01;31:*tbz2=01;31:*t2=01;31:*deb=01;31:*rpm=01;31:*jar=01;31:*war=01;31:*ear=01;31:*sar=01;31:*rar=01;31:*alz=01;31:*ace=01;31:*zoo=01;31:*cpio=01;31:*7z=01;31:*rz=01;31:*cab=01;31:*win=01;31:*swm=01;31:*dwm=01;31:*esd=01;31:*avif=01;35:*jpg=01;35:*jpeg=01;35:*mjpg=01;35:*mjpeg=01;35:*gif=01;35:*bmp=01;35:*pbm=01;35:*pgm=01;35:*ppm=01;35:*tga=01;35:*xbm=01;35:*xpm=01;35:*tif=01;35:*tiff=01;35:*png=01;35:*svg=01;35:*svgz=01;35:*mng=01;35:*pex=01;35:*mov=01;35:*mpg=01;35:*mpeg=01;35:*m2v=01;35:*m4v=01;35:*webm=01;35:*webp=01;35:*ogv=01;35:*mp4=01;35:*m4v=01;35:*mpqv=01;35:*vob=01;35:*qt=01;35:*nuv=01;35:*wmv=01;35:*asf=01;35:*rm=01;35:*rmvb=01;35:*flc=01;35:*avi=01;35:*fli=01;35:*flv=01;35:*gl=01;35:*dl=01;35:*xcf=01;35:*xwd=01;35:*yuv=01;35:*cgm=01;35:*emf=01;35:*ogv=01;35:*og=01;35:*aac=00;36:*au=00;36:*flac=00;36:*m4a=00;36:*mid=00;36:*midi=00;36:*mka=00;36:*mp3=00;36:*mpc=00;36:*ogg=00;36:*ra=00;36:*wav=00;36:*oga=00;36:*opus=00;36:*spx=00;36:*xspf=00;36:*#00;90:*#00;90:*bal=00;90:*crdownload=00;90:*dplg-dist=00;90:*dplg-new=00;90:*dplg-old=00;90:*dplg-tmp=00;90:*old=00;90:*orig=00;90:*part=00;90:*rej=00;90:*rpme w=00;90:*rpmorig=00;90:*rpmsave=00;90:*swp=00;90:*tmp=00;90:*ucf-dist=00;90:*ucf-new=00;90:*ucf-old=00;90:
SSH_CONNECTION=192.168.254.131 37782 192.168.254.131 22
LESSCLOSE=/usr/bin/lesspipe %s %s
XDG_SESSION_CLASS=user
TERM=xterm-256color
LESSOPEN=| /usr/bin/lesspipe %s
USER=nayab046
SHLVL=1
XDG_SESSION_ID=18
XDG_RUNTIME_DIR=/run/user/1000
SSH_CLIENT=192.168.254.131 37782 22
XDG_DATA_DIRS=/usr/local/share:/usr/share:/var/lib/napd/desktop
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
DBUS_SESSION_BUS_ADDRESS=unix:path=/run/user/1000/bus
SSH_TTY=/dev/pts/5
class=CC-BSE-5B
=/usr/bin/printenv
nayab046@nayab046:~$ |
```

EE_q1_env_filters.png

```
nayab046@nayab046:~$ echo "PATH: $PATH"
PATH: /usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
nayab046@nayab046:~$ echo "LANG: $LANG"
LANG: en_US.UTF-8
nayab046@nayab046:~$ echo "PWD: $PWD"
PWD: /home/nayab046
nayab046@nayab046:~$ |
```

Q2: Short-lived Student Info

EE_q2_exports.png

```
nayab046@nayab046:~$ export STUDENT_NAME="Nayab"
nayab046@nayab046:~$ export STUDENT_ROLL_NUMBER="2023-BSE-046"
nayab046@nayab046:~$ export STUDENT_SEMESTER="BSE-5B"
```

EE_q2_echoes.png

```
nayab046@nayab046:~$ echo "Name: $STUDENT_NAME, Roll: $STUDENT_ROLL_NUMBER, SEMESTER: $STUDENT_SEMESTER"
Name: Nayab, Roll: 2023-BSE-046, SEMESTER: BSE-5B
```

EE_q2_printenv_grep.png

```
nayab046@nayab046:~$ printenv | grep '^STUDENT_'
STUDENT_ROLL_SEMESTER=BSE-5B
STUDENT_NAME=Nayab
STUDENT_SEMESTER=BSE-5B
STUDENT_ROLL_NUMBER=2023-BSE-046
nayab046@nayab046:~$ |
```

EE_q2_after_restart.png


```
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-86-generic x86_64)

* Documentation:  https://help.ubuntu.com
* Management:    https://landscape.canonical.com
* Support:       https://ubuntu.com/pro

System information as of Fri Nov  7 05:55:39 AM UTC 2025

System load:  0.0           Processes:            229
Usage of /:   88.2% of 9.75GB Users logged in:       1
Memory usage: 8%           IPv4 address for ens33: 192.168.56.
Swap usage:   0%

=> / is using 88.2% of 9.75GB

Expanded Security Maintenance for Applications is not enabled.

29 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

12 additional security updates can be applied with ESM Apps.
Learn more about enabling ESM Apps service at https://ubuntu.com/esm
```

Q3: Make It Sticky (Persistence Check for Student Info)

EE_q3_after_source.png

```
nayab046@nayab046:~$ source ~/.bashrc
nayab046@nayab046:~$ printenv | grep '^STUDENT_'
STUDENT_ROLL_SEMESTER=BSE-5B
STUDENT_NAME=Nayab
STUDENT_SEMESTER=BSE-5B
STUDENT_ROLL_NUMBER=2023-BSE-046
nayab046@nayab046:~$ |
```

EE_q3_after_restart.png

```
nayab046@nayab046:~$ printenv | grep '^STUDENT_'
STUDENT_ROLL_SEMESTER=BSE-5B
STUDENT_NAME=Nayab
STUDENT_SEMESTER=BSE-5B
STUDENT_ROLL_NUMBER=2023-BSE-046
```

Q4: Firewall Rules: Block and Restore Ping (ICMP)

EE_q5_ufw_enable_status.png

```
nayab046@nayab046:~$ sudo ufw enable
[sudo] password for nayab046:
Command may disrupt existing ssh connections. Proceed with operation (y|n)? y
Firewall is active and enabled on system startup
nayab046@nayab046:~$ sudo ufw status
Status: active

To                         Action      From
--                         -
22/tcp                     ALLOW      Anywhere
22/tcp (v6)                ALLOW      Anywhere (v6)

nayab046@nayab046:~$
```

EE_q5_ufw_deny_ping_status.png

```
nayab046@nayab046:~$ sudo ufw reload
[sudo] password for nayab046:
Firewall reloaded
nayab046@nayab046:~$ sudo ufw status numbered
Status: active

To                         Action      From
--                         -
[ 1] 22/tcp                ALLOW IN    Anywhere
[ 2] 22/tcp (v6)           ALLOW IN    Anywhere (v6)

nayab046@nayab046:~$ |
```

EE_q5_ping_blocked.png

```
Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

EE_q5_ufw_allow_ping_status.png

```
nayab046@nayab046:~$ sudo ufw status
Status: active

To Action From
--
22/tcp ALLOW Anywhere
22/tcp (v6) ALLOW Anywhere (v6)

nayab046@nayab046:~$
```