



Fatima Jinnah Women University

Opening Portals of Excellence Through Higher Education

CLOUD COMPUTING LAB 7

Environment Variables, PATH, UFW, and SSH Key Authentication

Submitted to: Engr. Waqas Saleem

Engr. Muhammad Shahzad

Submitted by: Maham Saleem

Registration no.: 2023-BSE-035

Task 1 — Print & filter environment variables

task1_printenv_all.png

```
maham123@maham123:~$ printenv

#SHELL=/bin/bash
CREDENTIALS_DIRECTORY=/run/credentials/getty@tty1.service
MEMORY_PRESSURE_WRITE=c29tZSAYMDAwMDAgMjAwMDAwMAA=
XDG_SEAT=seat0
PWD=/home/maham123
LOGNAME=maham123
XDG_SESSION_TYPE=ttty
SYSTEMD_EXEC_PID=1363
HOME=/home/maham123
LANG=en_US.UTF-8
LS_COLORS=rs=0:di=01:34:ln=01:36:mh=00:pi=00:33:so=01:35:do=01:35:bd=00:33:01:cd=00:33:01:or=00:31:01:mi=00:su=37:41:sg=30:43:ca=00:tw=30:42:ow=34:42:st=37:44:e
x=01:32:*.tar=01:31:*.tgz=01:31:*.arc=01:31:*.arj=01:31:*.taz=01:31:*.lha=01:31:*.lzh=01:31:*.lzm=01:31:*.tlz=01:31:*.txz=01:31:*.tzo=01:31:*.t7z=0
1:31:*.zip=01:31:*.z=01:31:*.dz=01:31:*.gz=01:31:*.lrz=01:31:*.lzh=01:31:*.lzo=01:31:*.xz=01:31:*.zst=01:31:*.tzt=01:31:*.bz2=01:31:*.bz=01:31:*.tbz
2=01:31:*.tzt=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:*.paz=01:31:*.cab=01:31:*.wim=01:31:*.sum=01:31:*.dum=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:*.pcx=01:35
:*.mov=01:35:*.mpg=01:35:*.mpeg=01:35:*.m2v=01:35:*.mkv=01:35:*.webm=01:35:*.webp=01:35:*.ogm=01:35:*.ogg=01:35:*.mp4=01:35:*.m4v=01:35:*.mp4v=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=0
1:35:*.cgm=01:35:*.emf=01:35:*.ogv=01:35:*.ogx=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:*.~$=00:90:*.bak=00:90:*.crdownload=00:90:*.dpkg-dist=00:90:*.dpk
g-new=00:90:*.dpkg-old=00:90:*.dpkg-tmp=00:90:*.old=00:90:*.orig=00:90:*.part=00:90:*.rej=00:90:*.rpmnew=00:90:*.rpmorig=00:90:*.rpmsave=00:90:*.sup=00:90:*.tmp
=00:90:*.ucf-dist=00:90:*.ucf-new=00:90:*.ucf-old=00:90:
  ScreensMEMORY_PRESSURE_WATCH=/sys/fs/cgroup/system.slice/system-getty.slice/getty@tty1.service/memory.pressure
hINVOCATION_ID=70eada9f20174ff2af6593c3d65b4ebb
LESSCLOSE=/usr/bin/lesspipe %s %s
LESSSESSION_CLASS=user
TERM=linux
LESSOPEN=| /usr/bin/lesspipe %s
tUSER=maham123
SHLVL=1
XDG_VTNR=1
XDG_SESSION_ID=2
XDG_RUNTIME_DIR=/run/user/1000
XDG_DATA_DIRS=/usr/share/gnome:/home/maham123/.local/share/flatpak/exports/share:/var/lib/flatpak/exports/share:/usr/local/share:/usr/share:/var/lib/napd/des
ktop
HUSHLOGIN=FALSE
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
dbus_SESSION_BUS_ADDRESS=unix:path=/run/user/1000/bus
MAIL=/var/mail/maham123
_=/usr/bin/printenv
maham123@maham123:~$
```

task1_grep_shell_home_user.png

```
maham123@maham123:~$
maham123@maham123:~$ printenv | grep SHELL
SHELL=/bin/bash
maham123@maham123:~$
maham123@maham123:~$ printenv | grep HOME
HOME=/home/maham123
maham123@maham123:~$
maham123@maham123:~$ printenv | grep USER
USER=maham123
maham123@maham123:~$ _
```

Task 2 — Export DB_* variables temporarily and observe scope

task2_exports_all.png

```
maham123@maham123:~$ export DB_URL="postgres://db.example.local:5432/mydb"
maham123@maham123:~$ export DB_USER="labuser"
maham123@maham123:~$ export DB_PASSWORD="labpass123"
maham123@maham123:~$
```

task2_echoes_all.png

```
maham123@maham123:~$  
maham123@maham123:~$ echo "$DB_URL"  
postgres://db.example.local:5432/mydb  
maham123@maham123:~$ echo "$DB_USER"  
labuser  
maham123@maham123:~$ echo "$DB_PASSWORD"  
labpass123  
maham123@maham123:~$
```

task2_printenv_grep_db.png

```
labpass123  
maham123@maham123:~$ printenv | grep '^DB_'  
DB_PASSWORD=labpass123  
DB_USER=labuser  
DB_URL=postgres://db.example.local:5432/mydb  
maham123@maham123:~$
```

task2_after_restart_checks.png

```
The list of available updates is more than a week old.  
To check for new updates run: sudo apt update  
  
maham123@maham123:~$ echo "$DB_URL"  
  
maham123@maham123:~$ printenv | grep '^DB_'  
maham123@maham123:~$
```

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

task3_bashrc_added.png

```
... /usr/share/bash-completion/bash_completion  
elif [ -f /etc/bash_completion ]; then  
    . /etc/bash_completion  
fi  
fi  
export DB_URL="postgres://db.example.local:5432/mydb"  
  
export DB_USER="labuser"  
  
export DB_PASSWORD="labpass123"  
  
...  
...  
".bashrc" 124L, 3886B written  
maham123@maham123:~$
```

task3_source_and_verification.png

```
.bashrc: 124L, 366B written
maham123@maham123:~$ source ~/.bashrc
maham123@maham123:~$ echo "$DB_URL"
postgres://db.example.local:5432/mydb
maham123@maham123:~$ echo "$DB_USER"
labuser
maham123@maham123:~$ echo "$DB_PASSWORD"
labpass123
maham123@maham123:~$ printenv | grep '^DB_'
DB_PASSWORD=labpass123
DB_USER=labuser
DB_URL=postgres://db.example.local:5432/mydb
maham123@maham123:~$
```

task3_after_restart_persistent.png

```
maham123@maham123:~$ echo "$DB_URL"
postgres://db.example.local:5432/mydb
maham123@maham123:~$ printenv | grep '^DB_'
DB_PASSWORD=labpass123
DB_USER=labuser
DB_URL=postgres://db.example.local:5432/mydb
maham123@maham123:~$
```

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

task4_etc_environment_before.png

```
postgres://db.example.local:5432/mydb
maham123@maham123:~$ sudo cat /etc/environment
[sudo] password for maham123:
PATH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin"
maham123@maham123:~$ _
```

task4_echo_path_before.png

```
PATH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin"
maham123@maham123:~$ echo "$PATH"
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
maham123@maham123:~$ _
```

task4_etc_environment_after.png

```
sh: 1: cannot create /etc/environment: Directory nonexistent
maham123@maham123:~$ sudo cat /etc/environment
Add a line (replace <your_class_name> with your class id):

# Class="CC-2023-BSE-035"

# Save & exit

# Screenshot: task4_etc_environment_edit_vim.png

TH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin"
```

task4_echo_class_and_path.png

```
class= CC-YOUR-CLASSNAME
maham123@maham123:~$ echo $class

maham123@maham123:~$ echo "$PATH"
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
maham123@maham123:~$
```

task4_welcome_create_and_chmod.png

```
maham123@maham123:~$ cat > ~/welcome <<'EOF'
> #!/bin/bash
>
> cat > ~/welcome <<'EOF'
#!/bin/bash

echo "Welcome to Cloud Computing $USER"
>
> EOF

chmoham123@maham123:~$
maham123@maham123:~$
maham123@maham123:~$
maham123@maham123:~$ chmod +x ~/welcome
maham123@maham123:~$
maham123@maham123:~$ ls -l ~/welcome
-rwxrwxr-x 1 maham123 maham123 91 Nov 22 16:43 /home/maham123/welcome
maham123@maham123:~$
```

task4_welcome_run_dot.png

```
-rwxrwxr-x 1 maham123 maham123 91 Nov 22 16:43 /home/maham123/welcome
maham123@maham123:~$ cd ~
maham123@maham123:~$
maham123@maham123:~$ ./welcome
./welcome: line 7: warning: here-document at line 3 delimited by end-of-file (wanted `EOF')
maham123@maham123:~$
```

task4_bashrc_path_line.png

```
if [ -d /usr/share/bash-completion/bash_completion ]; then
    . /usr/share/bash-completion/bash_completion
elif [ -d /etc/bash_completion ]; then
    . /etc/bash_completion
fi
fi
export DB_URL="postgres://db.example.local:5432/mydb"

export DB_USER="labuser"

export DB_PASSWORD="labpass123"

PATH=$PATH:~
"~/bashrc" 124L, 3898B
```

task4_bashrc_source_and_welcome.png

```
maham123@maham123:~$ source ~/.bashrc
maham123@maham123:~$ cd ~
maham123@maham123:~$ welcome
Welcome to Cloud Computing maham123
maham123@maham123:~$
```

Task 5 — Block and allow SSH using ufw (firewall)

task5_ufw_enable_and_status.png

```
valid_irt forever preferred_irt forever
maham123@maham123:~$ sudo ufw enable
Firewall is active and enabled on system startup
maham123@maham123:~$ sudo ufw status verbose
Status: active
Logging: on (low)
Default: deny (incoming), allow (outgoing), disabled (routed)
New profiles: skip

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

maham123@maham123:~$ _
```

task5_ufw_deny_22_and_status.png

```
maham123@maham123:~$ sudo ufw deny 22/tcp
Rule updated
Rule updated (v6)
maham123@maham123:~$ sudo ufw status numbered
Status: active

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

maham123@maham123:~$
```

task5_ssh_attempt_blocked.png

```
User@LAPTOP-UGUQFEBV MINGW64 ~ (collab)
$ ssh maham123@192.168.18.16
ssh: connect to host 192.168.18.16 port 22: Connection timed out

User@LAPTOP-UGUQFEBV MINGW64 ~ (collab)
$
```

task5_ufw_allow_reload_status.png

```
maham123@maham123:~$ sudo ufw allow 22/tcp
Rule updated
Rule updated (v6)
maham123@maham123:~$ sudo ufw reload
Firewall reloaded
maham123@maham123:~$ sudo ufw status
Status: active

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

maham123@maham123:~$
```

task5_ssh_success_after_allow.png

```
User@LAPTOP-UGUQFEBV MINGW64 ~ (collab)
$ ssh maham123@192.168.18.16
The authenticity of host '192.168.18.16 (192.168.18.16)' can't be esta
blished.
ED25519 key fingerprint is SHA256:bGch46/l+Trd/P7rUtBwIJLDkPdLD9Wl54Cf
ZND7dAs.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? y
Please type 'yes', 'no' or the fingerprint: y
Please type 'yes', 'no' or the fingerprint: yes
Warning: Permanently added '192.168.18.16' (ED25519) to the list of kn
own hosts.
maham123@192.168.18.16's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-87-generic x86_64)

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

System information as of Sat Nov 22 08:57:27 PM UTC 2025

System load: 0.0 Processes: 231
Usage of /: 75.0% of 9.75GB Users logged in: 1
Memory usage: 17% IPv4 address for ens33: 192.168.18.1
Swap usage: 0%

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

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

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

Last login: Sat Oct 25 08:17:43 2025 from 192.168.28.1
maham123@maham123:~$
```


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

task6_windows_sshkey_and_list.png

```
maham123@maham123:~$ ssh-keygen -t ed25519 -f ~/.ssh/id_lab7 -C "lab_key"
Generating public/private ed25519 key pair.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/maham123/.ssh/id_lab7
Your public key has been saved in /home/maham123/.ssh/id_lab7.pub
The key fingerprint is:
SHA256:XcArpmOhgRzfxw0QrVBnE80JgrqUh1RuoGvrUgVw6Sw lab_key
The key's randomart image is:
+--[ED25519 256]--+
|.ooo o=+**..|
|.o* o +o.=.|
|o= X o o o ..|
|E.@ + + =.o.|
|. = o o =S..|
|. + .+|
| o . .|
|o|
|..|
+-----[SHA256]-----+
maham123@maham123:~$ ls -la ~/.ssh
total 16
drwx----- 2 maham123 maham123 4096 Nov 22 20:59 .
drwxr-x--- 20 maham123 maham123 4096 Nov 22 17:00 ..
-rw----- 1 maham123 maham123 0 Oct 3 06:38 authorized_keys
-rw----- 1 maham123 maham123 399 Nov 22 20:59 id_lab7
-rw-r--r-- 1 maham123 maham123 89 Nov 22 20:59 id_lab7.pub
maham123@maham123:~$
```

task6_windows_public_key.png

```
-rw-r--r-- 1 maham123 maham123 89 Nov 22 20:59 id_lab7.pub
maham123@maham123:~$ cat ~/.ssh/id_lab7.pub
ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAAAIAUnhGxDRu1LcIqs8UvsMmoM+hA2PEngKU4
q98wwOeUU lab_key
maham123@maham123:~$
```

task6_windows_known_hosts_cleared_and_empty.png

```
maham123@maham123:~$ > ~/.ssh/known_hosts
maham123@maham123:~$ cat ~/.ssh/known_hosts
maham123@maham123:~$ |
```


task6_windows_ssh_accept_hostkey_and_login.png

```
maham123@maham123:~$ ssh maham123@192.168.18.16
The authenticity of host '192.168.18.16 (192.168.18.16)' can't be estab
lished.
ED25519 key fingerprint is SHA256:bGcH46/1+Trd/P7rUtBwIJLDkPdLD9Wl54CfZ
ND7dAs.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? ye
s
Warning: Permanently added '192.168.18.16' (ED25519) to the list of kno
wn hosts.
maham123@192.168.18.16's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-87-generic x86_64)

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

System information as of Sat Nov 22 09:05:45 PM UTC 2025

System load:  0.08               Processes:           237
Usage of /:   75.0% of 9.75GB    Users logged in:    1
Memory usage: 17%               IPv4 address for ens33: 192.168.18.16
Swap usage:   0%

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

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

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

Last login: Sat Nov 22 20:57:28 2025 from 192.168.18.131
maham123@maham123:~$
```

task6_windows_known_hosts_after_connect.png

```
PS C:\Users\USer> type $env:USERPROFILE\.ssh\known_hosts
192.168.18.16 ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAAAICKNE1DZ/Q1fG0mFccsy+bbNps
JNQCgwL/6pZt2Zto9R
192.168.18.16 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQGCyU686UYSDsc5Y/TlbWrP5Cf
zOSlnc6L4nnjM5p/svKJep8jgIQYfG6DkXcFeKC0bwAaGs9+TMXqG1YT3TWOAxlX/VhVHSwVxc7
oJeMyqsMMmqWOG4bcimjHQIPeHyrX1oXqnCh4KrZ/xVGcxDcKWrThlofm4wmuITYDT1Xr2IohZb
ODy5CWbGG25VcaPcGiecXgI4ILZMFNB7EkV7eJQZC0DvNXJ2XddhLirido8NJw3ivhNgTVNtMTw7J
LDEYcTDrViNAzYc5QUou7MQzM61cEC77K/y3deCddQggFFBGoutrj1bCCqjK3SfUj7JSljfwODLl
/kXJEQr6gjFkN9cSJh+zwCbF75w79qVGtgbZruTzdYivCdSSud2ppdq9RiEXdmVZtrVn93NAfC0G
Zzm9GcVJi9ZI94bSx8U17wEhNAftmpGdB+bZAMTZycb1E/XRLzx6uy3UZc/gqBaU0EyGfS0ecTy
wGp7L55EyZiKRAt+aGbUT9L7o9nNFBt+0=
192.168.18.16 ecdsa-sha2-nistp256 AAAAE2VjZHNhLXNoYTItbmlzdHAyNTYAAAAIbmlzdH
AyNTYAAABBBiUDe7br5UG3rH9XQ00anjoLC27J9YFFUCV9Azb1n4Y30XW7eDQx/UwyyaI0VbtK5
whmmUWvDIGDNyZAmrFHkQ=
PS C:\Users\USer>
```

task6_server_clear_authorized_keys.png

```
maham123@maham123:~$ mkdir -p ~/.ssh
maham123@maham123:~$ chmod 700 ~/.ssh
maham123@maham123:~$ > ~/.ssh/authorized_keys
maham123@maham123:~$ ls -la ~/.ssh
total 24
drwx----- 2 maham123 maham123 4096 Nov 22 21:05 .
drwxr-x--- 20 maham123 maham123 4096 Nov 22 17:00 ..
-rw----- 1 maham123 maham123   0 Nov 22 21:12 authorized_keys
-rw----- 1 maham123 maham123  399 Nov 22 20:59 id_lab7
-rw-r--r-- 1 maham123 maham123   89 Nov 22 20:59 id_lab7.pub
-rw----- 1 maham123 maham123  978 Nov 22 21:05 known_hosts
-rw-rw-r-- 1 maham123 maham123  142 Nov 22 21:05 known_hosts.old
maham123@maham123:~$
```

task6_server_add_key_and_show.png

```
maham123@maham123:~$
maham123@maham123:~$ echo "ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAAAICKNE1DZ/Q1fG0mFcCsy+bbNpsJNQcGwL/6pZt22to9R" >> ~/.ssh/authorized_keys
maham123@maham123:~$ chmod 600 ~/.ssh/authorized_keys
maham123@maham123:~$ cat ~/.ssh/authorized_keys
ssh-ed25519 AAAA...your_public_key_here... lab_key
ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAAAICKNE1DZ/Q1fG0mFcCsy+bbNpsJNQcGwL/6pZt22to9R
maham123@maham123:~$
```

task6_ssh_passwordless_login.png

```
ssh: Could not resolve hostname 192.168.18.16: Name or service not known
maham123@maham123:~$ ssh maham123@192.168.18.16
maham123@192.168.18.16's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-87-generic x86_64)

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

System information as of Sat Nov 22 09:19:58 PM UTC 2025

System load:  0.0               Processes:           240
Usage of /:   75.0% of 9.75GB    Users logged in:    1
Memory usage: 17%              IPv4 address for ens33: 192.168.18.16
Swap usage:   0%

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

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

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

Last login: Sat Nov 22 21:05:46 2025 from 192.168.18.16
maham123@maham123:~$
```

task6_ssh_with_identity_file.png

```
maham123@maham123:~$ ssh -i ~/.ssh/id_lab7 maham123@192.168.18.16
maham123@192.168.18.16's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-87-generic x86_64)

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

System information as of Sat Nov 22 09:22:34 PM UTC 2025

System load:  0.01               Processes:           242
Usage of /:   75.0% of 9.75GB    Users logged in:    1
Memory usage: 18%               IPv4 address for ens33: 192.168.18.16
Swap usage:   0%

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

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

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

Last login: Sat Nov 22 21:19:59 2025 from 192.168.18.16
maham123@maham123:~$
```