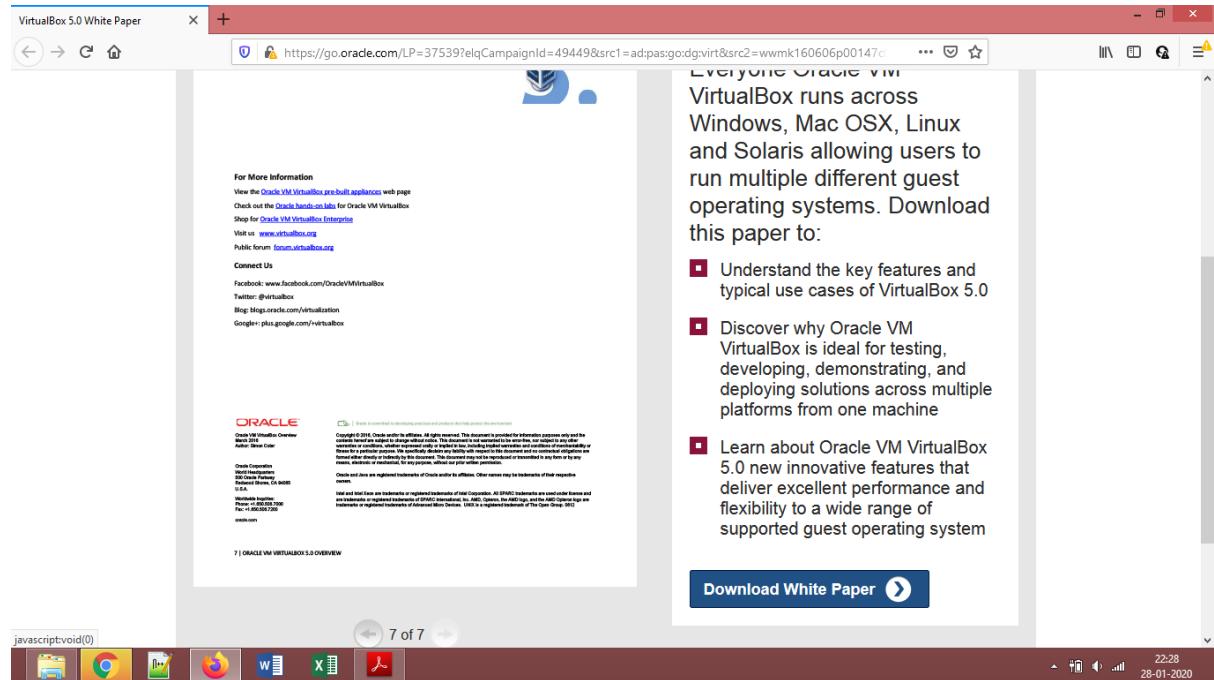
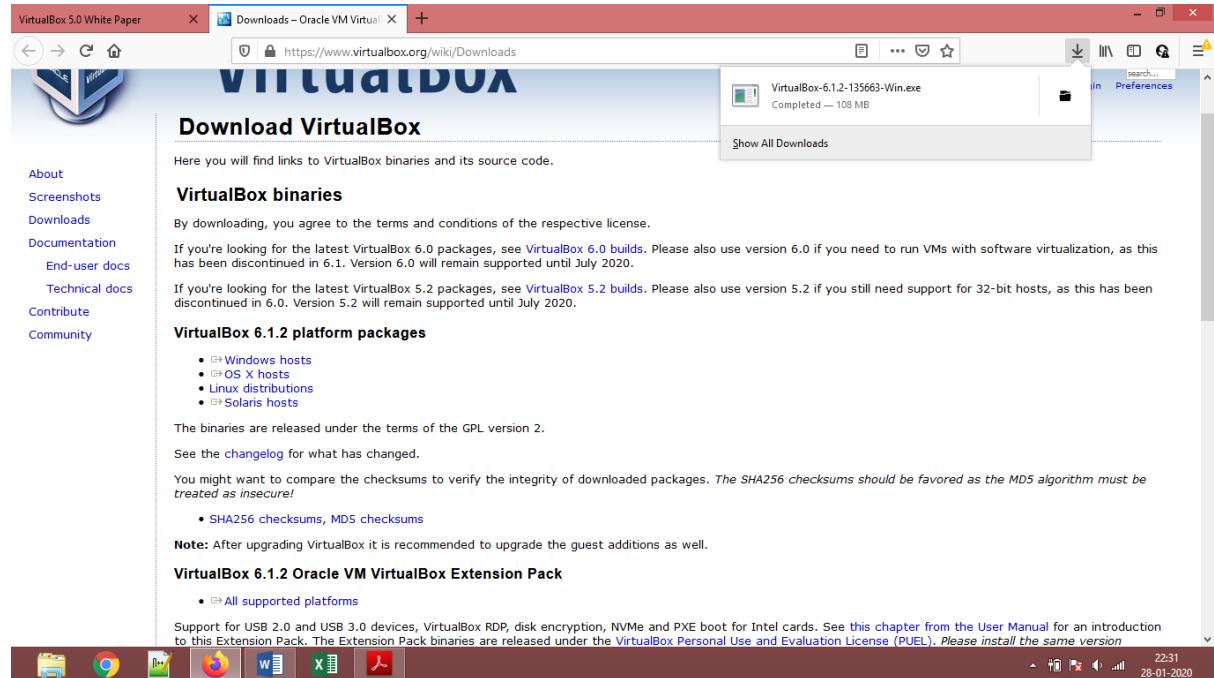


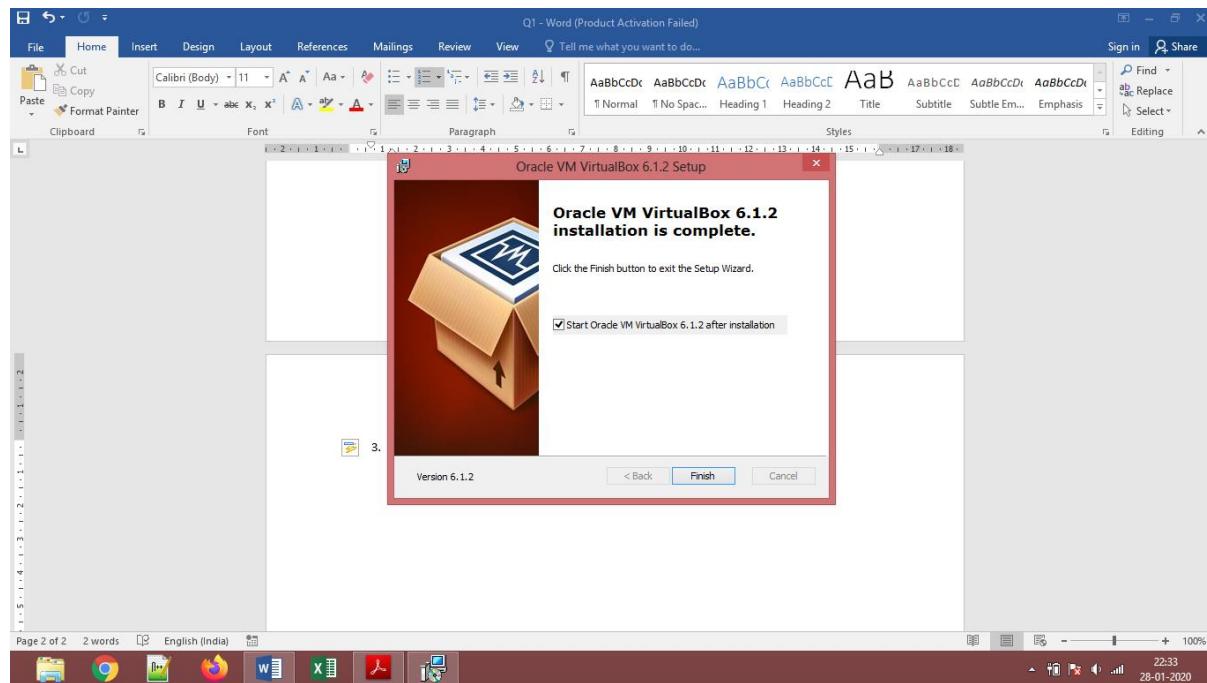
Q1 a.)



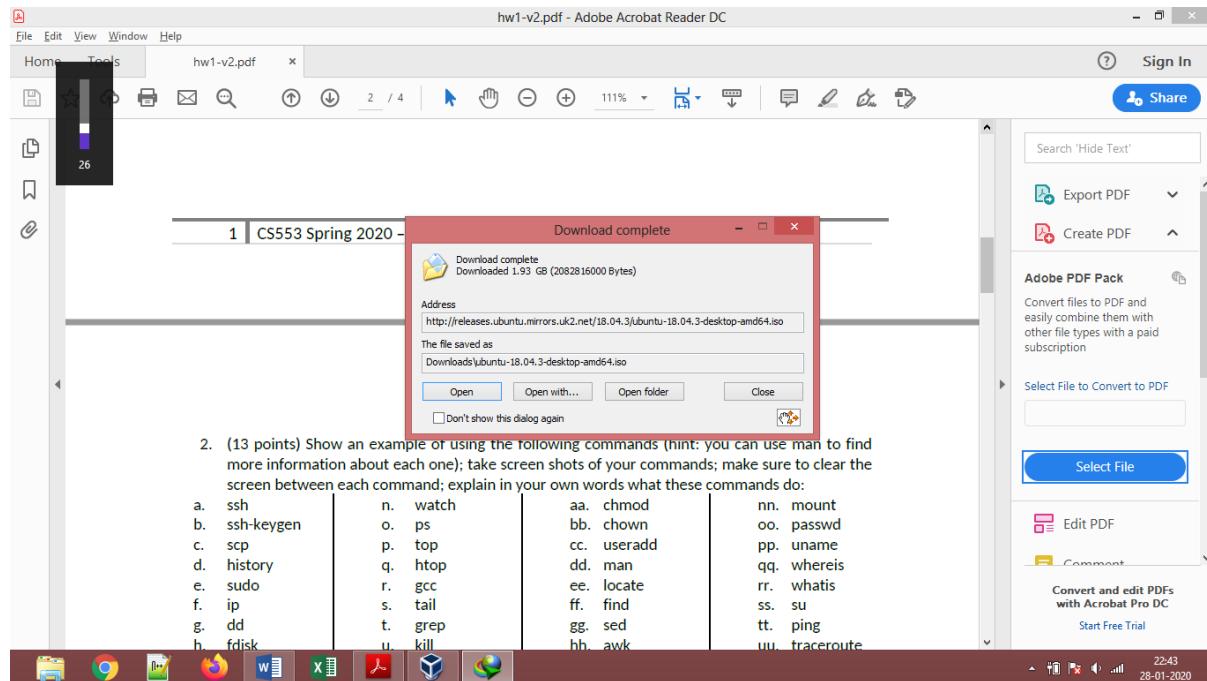
Q1 b.)



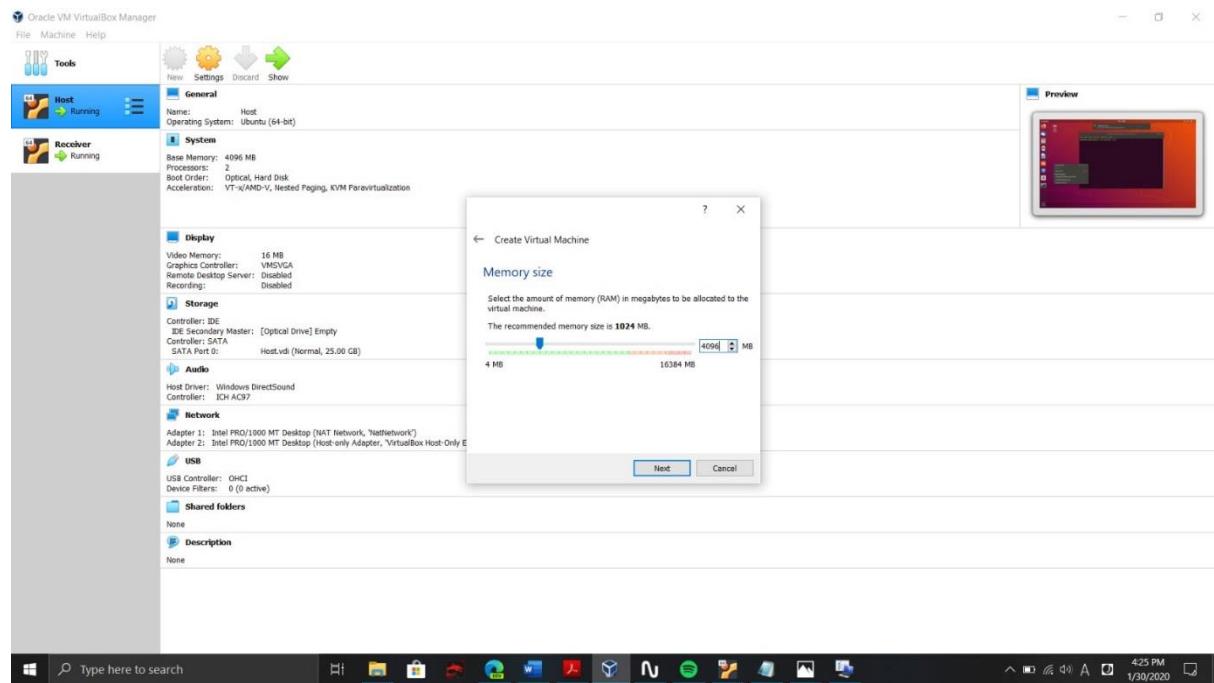
Q1 c.)



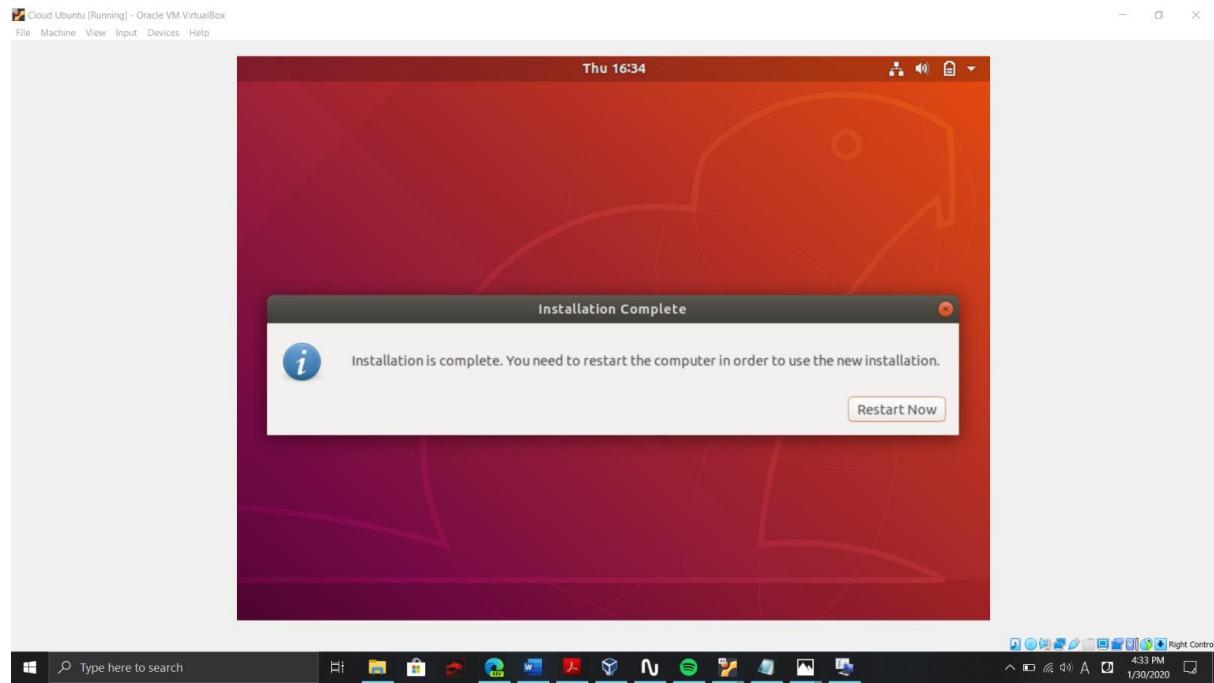
Q1 d.)



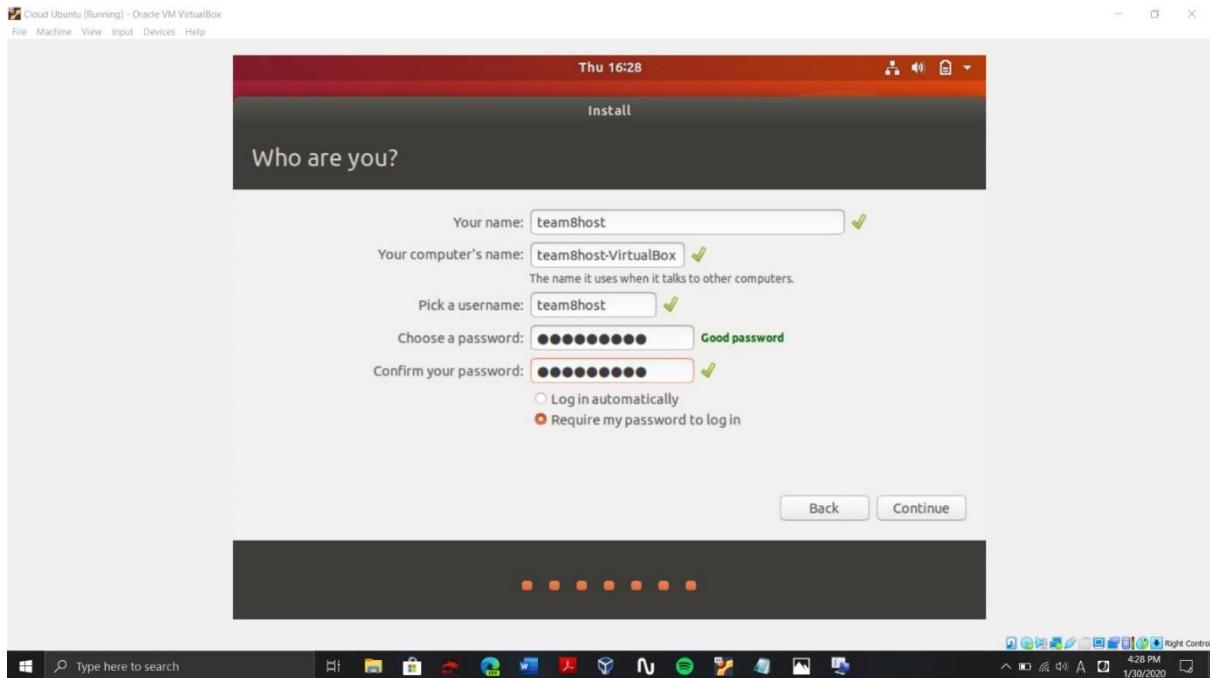
Q1 e.)



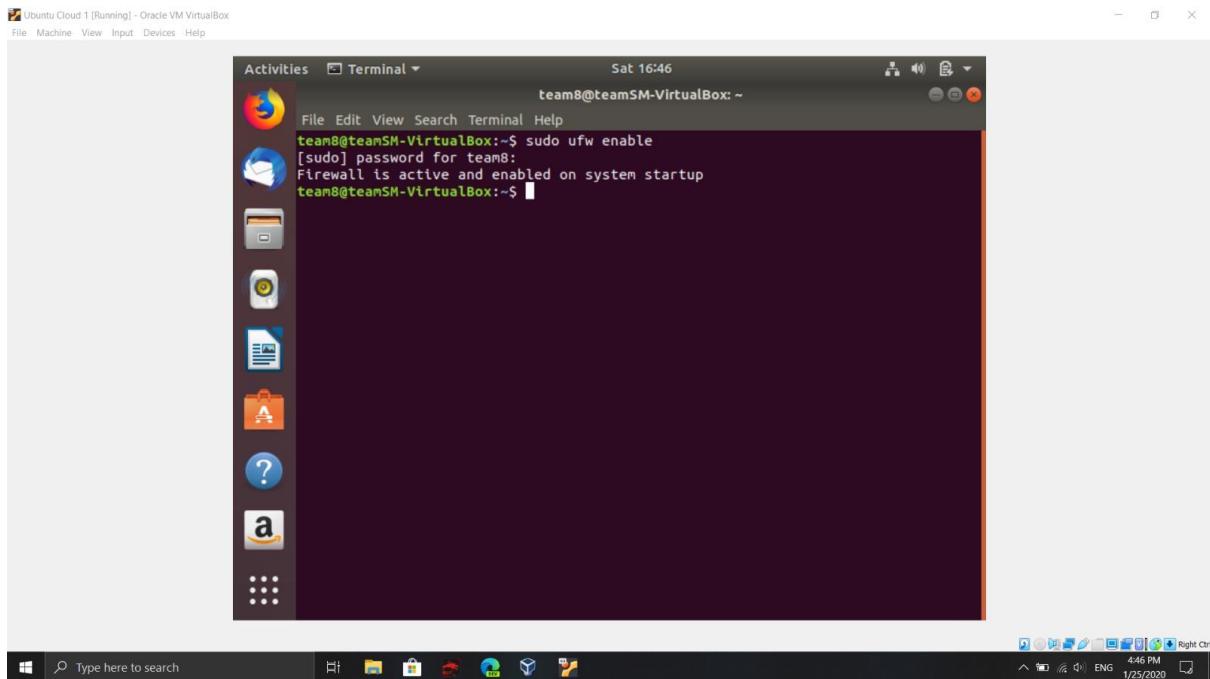
Q1 f.)



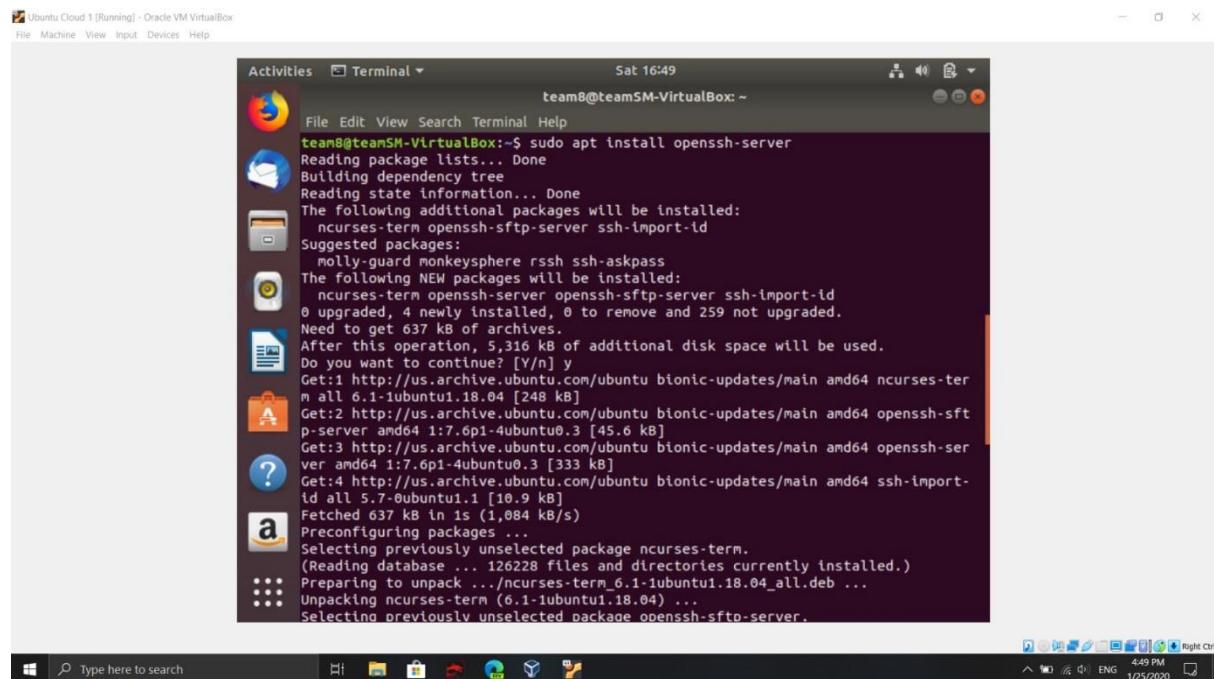
Q1 g.)



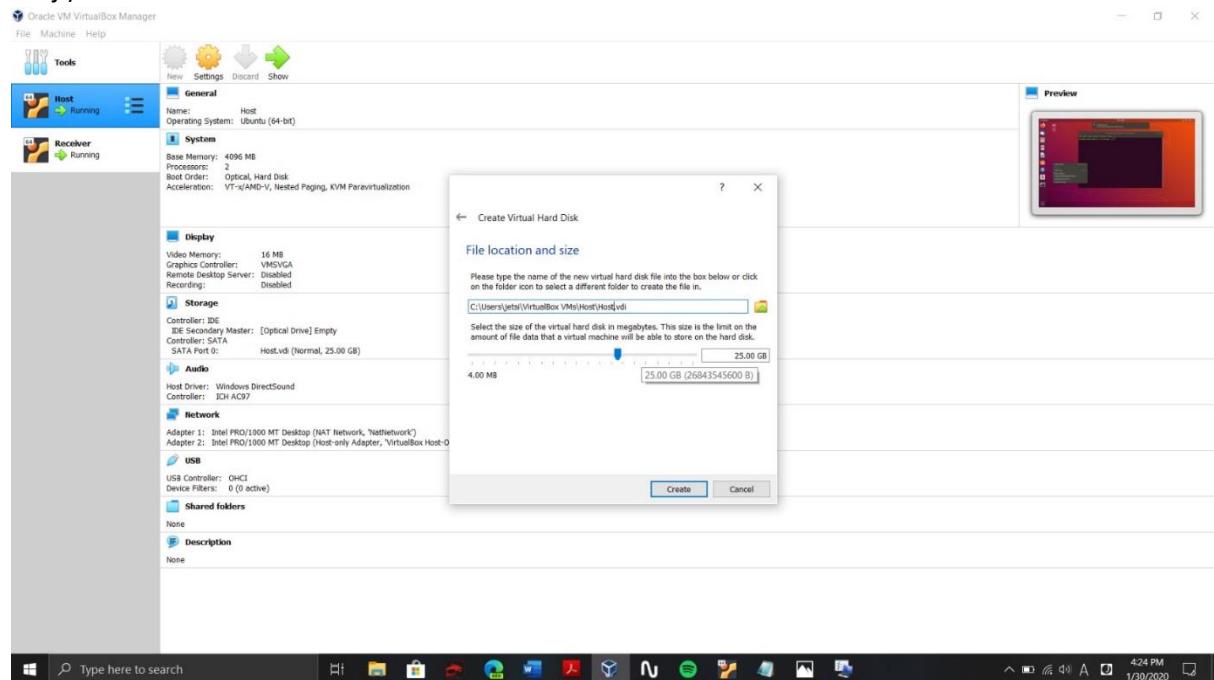
Q1 h.)



Q1 i.)



Q1 j.)



Q1 k.)

Host [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal Sun 18:37 team@teamhost@teamhost-VirtualBox:~

```
team@teamhost@teamhost-VirtualBox:~$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/team@host/.ssh/id_rsa): hostkey
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in hostkey.
Your public key has been saved in hostkey.pub.
The key fingerprint is:
SHA256:ZoElkhQhCyYhb4ifiled0hP0rrTTCrz+ayM4ucz4bo team@host@teamhost-VirtualBox
The key's randomart image is:
+---[RSA 2048]---+
| B+o+o |
| + o o + |
| . . o . .
| . . o . .
| oo + + |
| o + B + |
| .ooOo= . |
| :oEOOo= |
+---[SHA256]---+
team@teamhost@teamhost-VirtualBox:~$
```

Type here to search

File Edit View Search Terminal Help

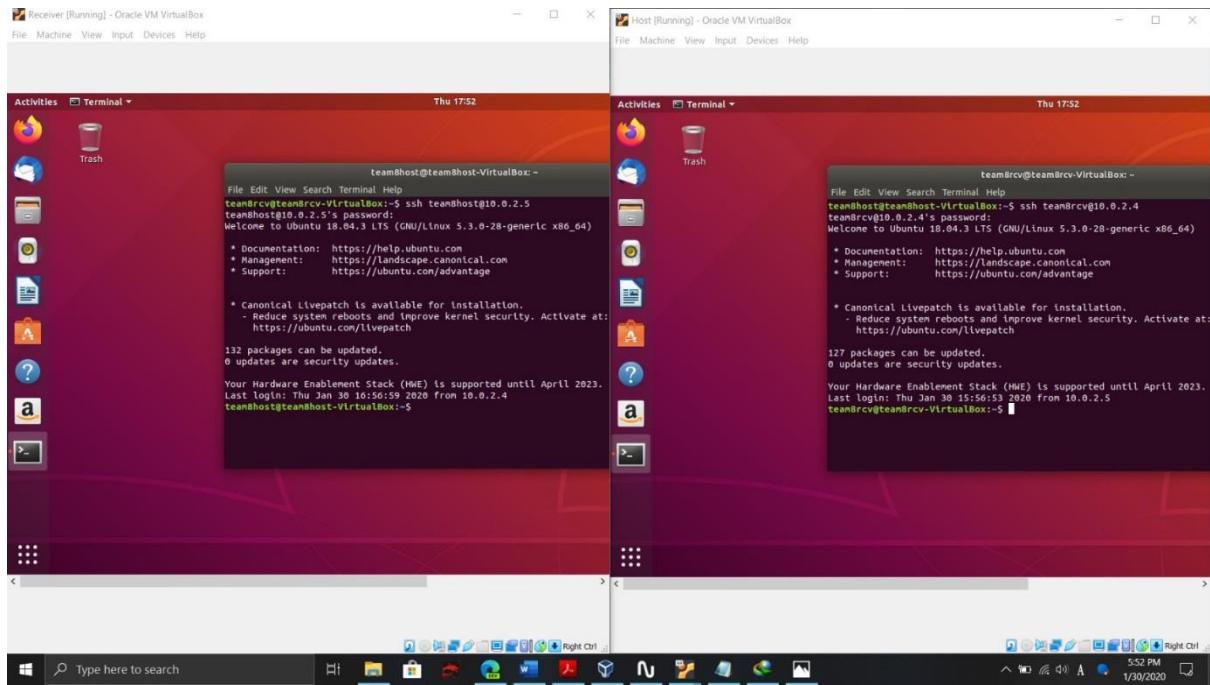
Activities Terminal Thu 17:49 team@team@teamhost-VirtualBox:~

```
team@team@teamhost-VirtualBox:~$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/team@host/.ssh/id_rsa): rcvkeygen
rcvkeygen already exists.
Overwrite (y/n)? y
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in rcvkeygen.
Your public key has been saved in rcvkeygen.pub.
The key fingerprint is:
SHA256:z8smKCGjbeeEp0eBmNUJLys+jfKLhBacuULzYPjlx0 team@team@teamhost-VirtualBox
The key's randomart image is:
+---[RSA 2048]---+
| .+Bo |
| . . +o= |
| . . . o.E |
| .o . o + |
| . . . XoO |
| . . = Oo. |
| . . + .o. |
| ..+.. o... |
| ..+.. o... |
+---[SHA256]---+
team@team@teamhost-VirtualBox:~$
```

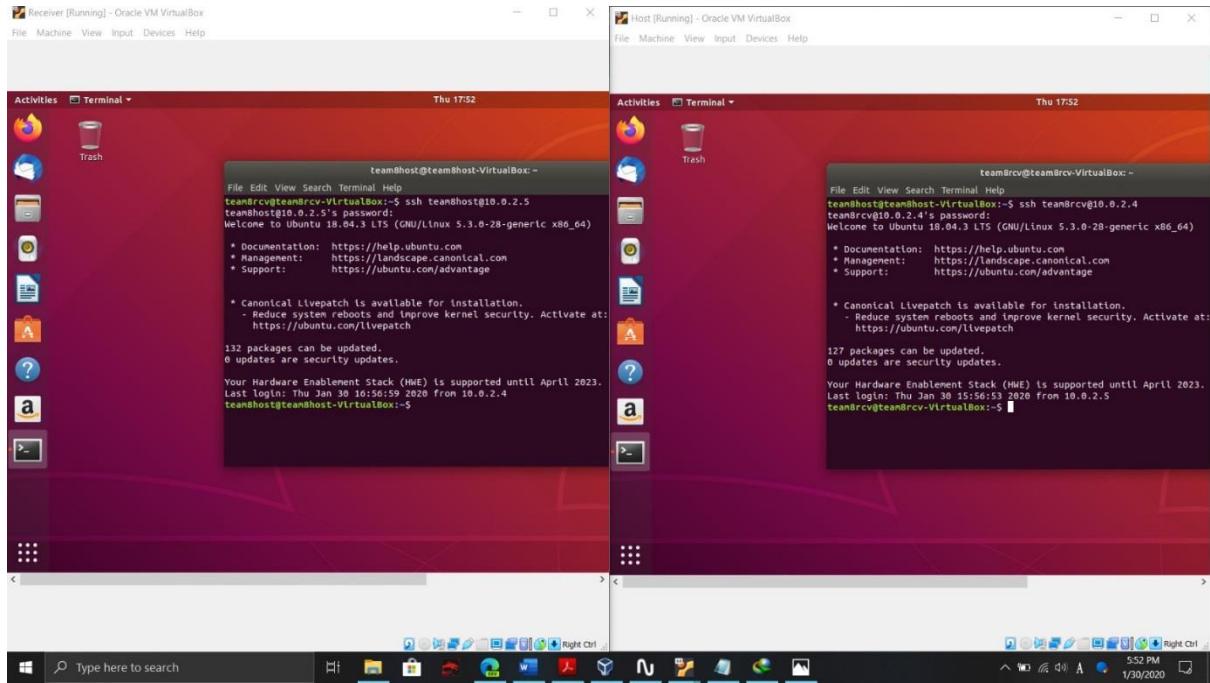
Type here to search

File Edit View Search Terminal Help

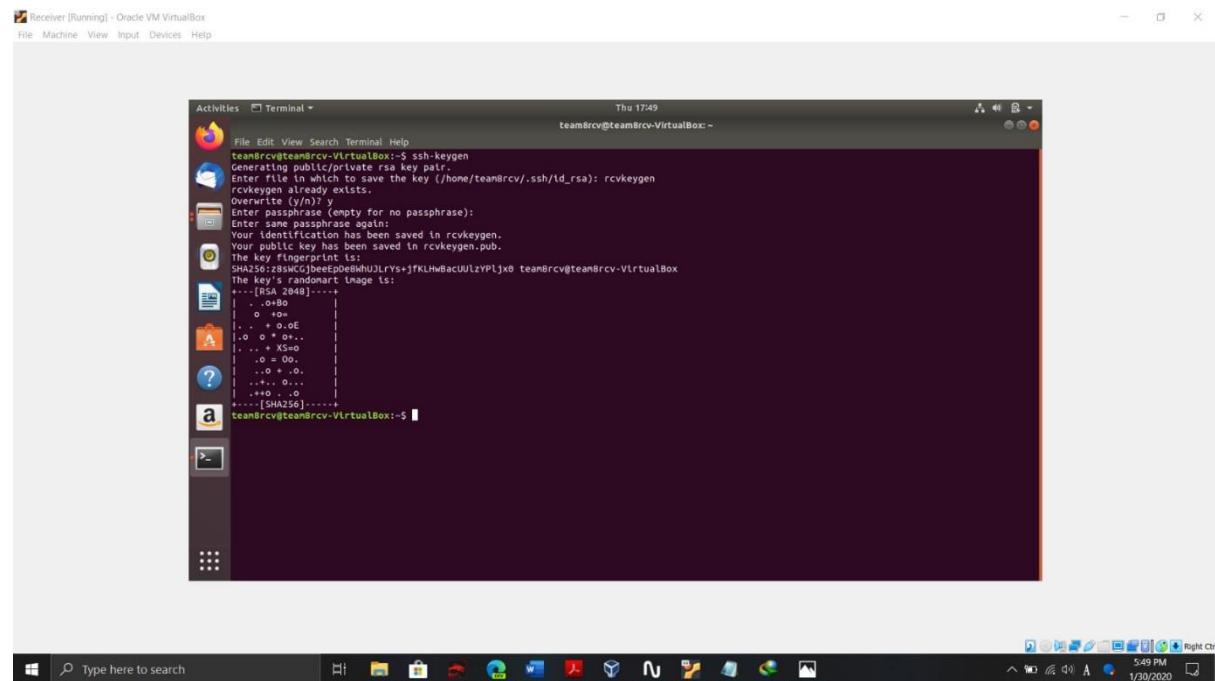
Q1 I.)



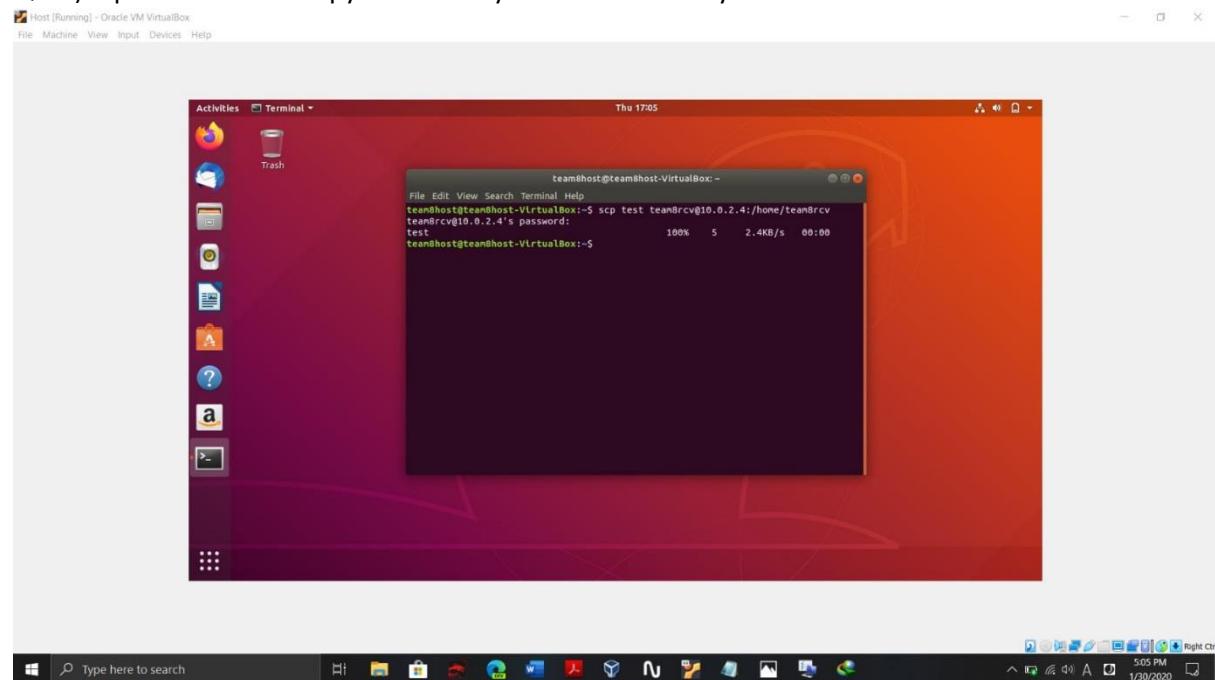
Q2 a.) ssh - it creates a connection between two systems



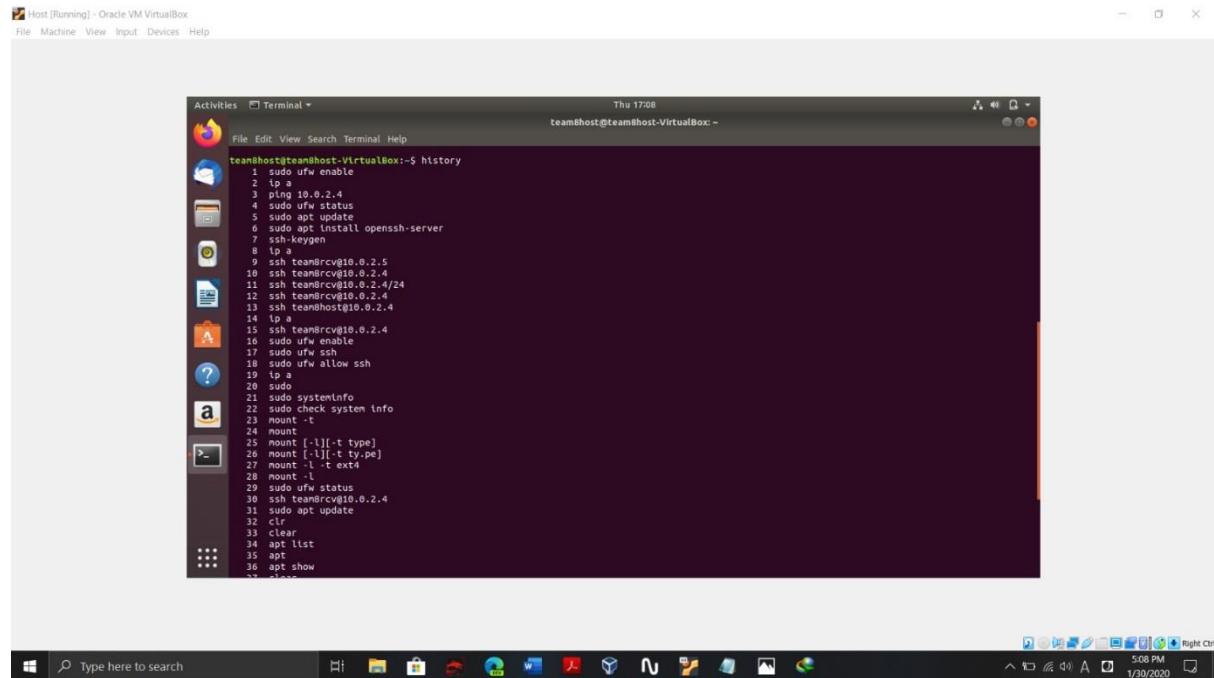
Q2 b.) ssh-keygen – It creates a key pair for public key authentication



Q2 c.) scp – It is used to copy from one system to another system

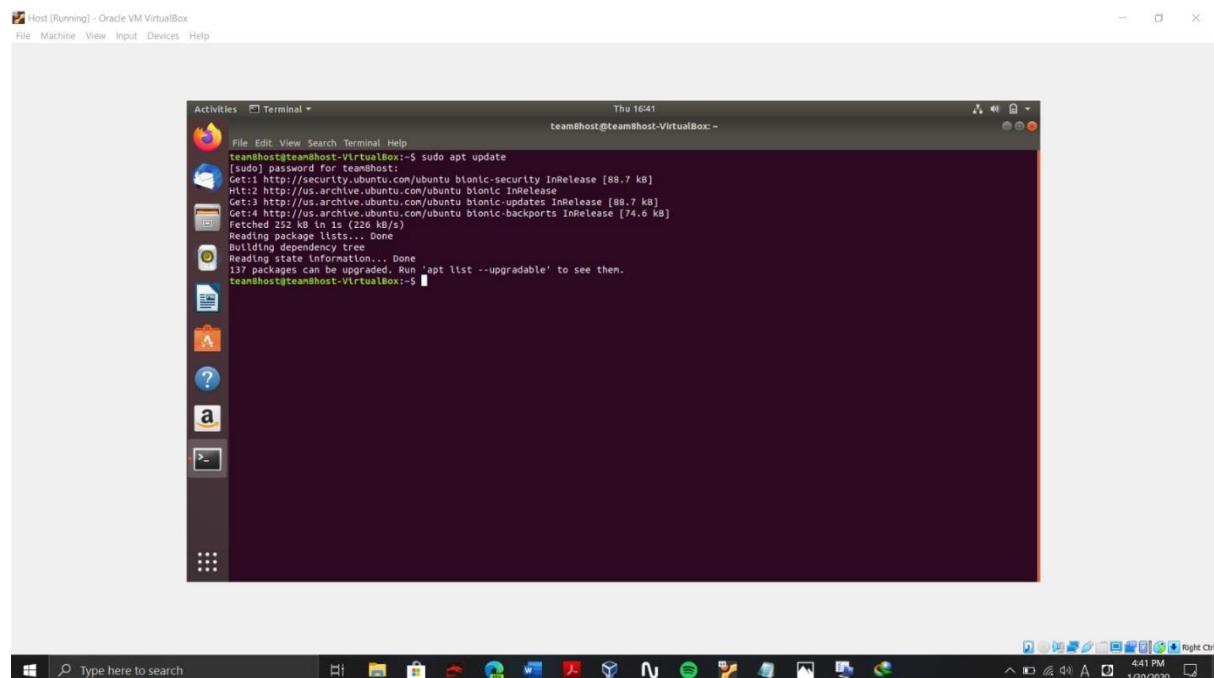


Q2 d.) history – shows command history up to 500 commands



A screenshot of a Linux desktop environment, likely Ubuntu, running in Oracle VM VirtualBox. The terminal window shows the command history for the user 'teamHost'. The history includes various system management commands such as `sudo ufw enable`, `ping 10.0.2.4`, `sudo apt update`, `sudo apt install openssh-server`, `ssh-keygen`, `ip a`, `ssh team@rcv@10.0.2.5`, `ssh team@rcv@10.0.2.4`, `ssh team@rcv@10.0.2.4/24`, `ssh team@host@10.0.2.4`, `ip a`, `ssh team@rcv@10.0.2.4`, `sudo ufw enable`, `sudo ufw ssh`, `sudo ufw allow ssh`, `ip a`, `sudo`, `sudo systemInfo`, `sudo check system info`, `mount -t`, `mount`, `mount {-l}[-t type]`, `mount {-l}[-t type]`, `mount {-l} -t ext4`, `mount -l`, `sudo ufw status`, `ssh team@rcv@10.0.2.4`, `sudo apt update`, `clear`, `clear`, `apt list`, `apt`, `apt show`, and `exit`.

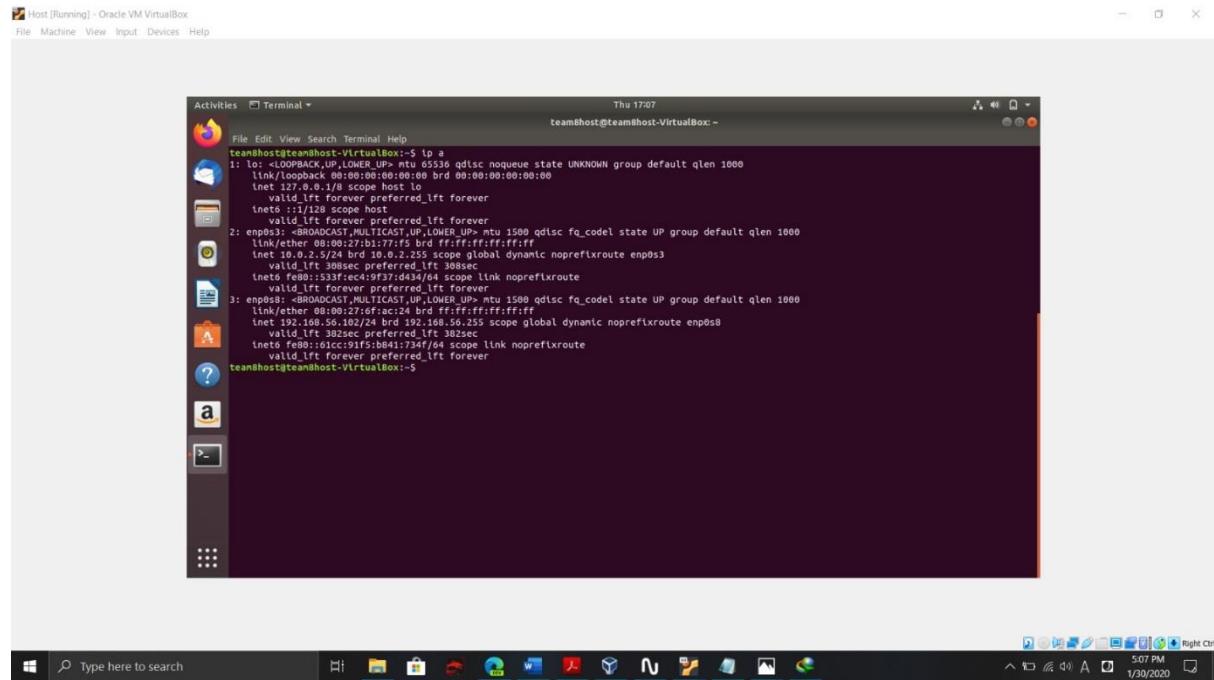
Q2 e.) sudo – It allows a user to run a command as super user or other user



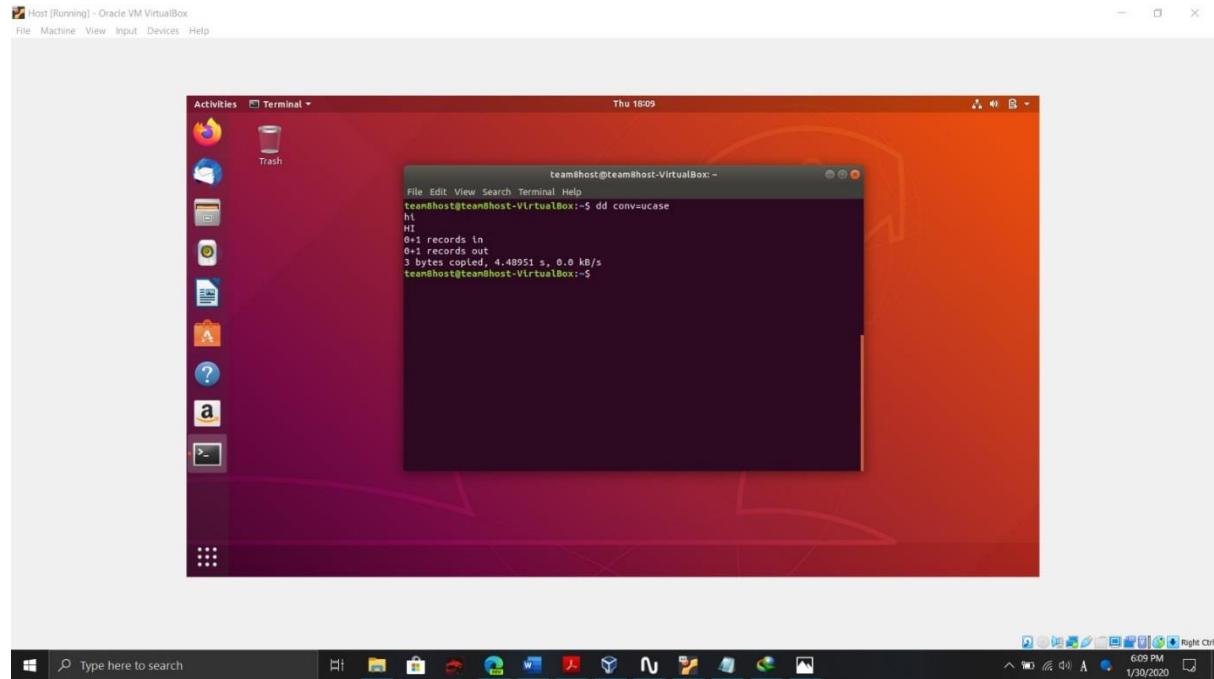
A screenshot of a Windows desktop environment showing a terminal window with the command `sudo apt update` run by the user 'teamHost'. The output shows the package lists being updated from the 'bionic' repository. The terminal window title is 'teamHost@teamHost-VirtualBox ~' and the date and time are 'Thu 16:41'.

```
teamHost@teamHost-VirtualBox ~$ sudo apt update
[sudo] password for teamHost:
Get:1 http://security.ubuntu.com/ubuntu bionic-security InRelease [88.7 kB]
Hit:2 http://us.archive.ubuntu.com/ubuntu bionic InRelease
Get:3 http://us.archive.ubuntu.com/ubuntu bionic-updates InRelease [88.7 kB]
Get:4 http://us.archive.ubuntu.com/ubuntu bionic-backports InRelease [74.6 kB]
Fetched 252 kB in 0s (1.0 kB/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
137 packages can be upgraded. Run 'apt list --upgradable' to see them.
teamHost@teamHost-VirtualBox ~$
```

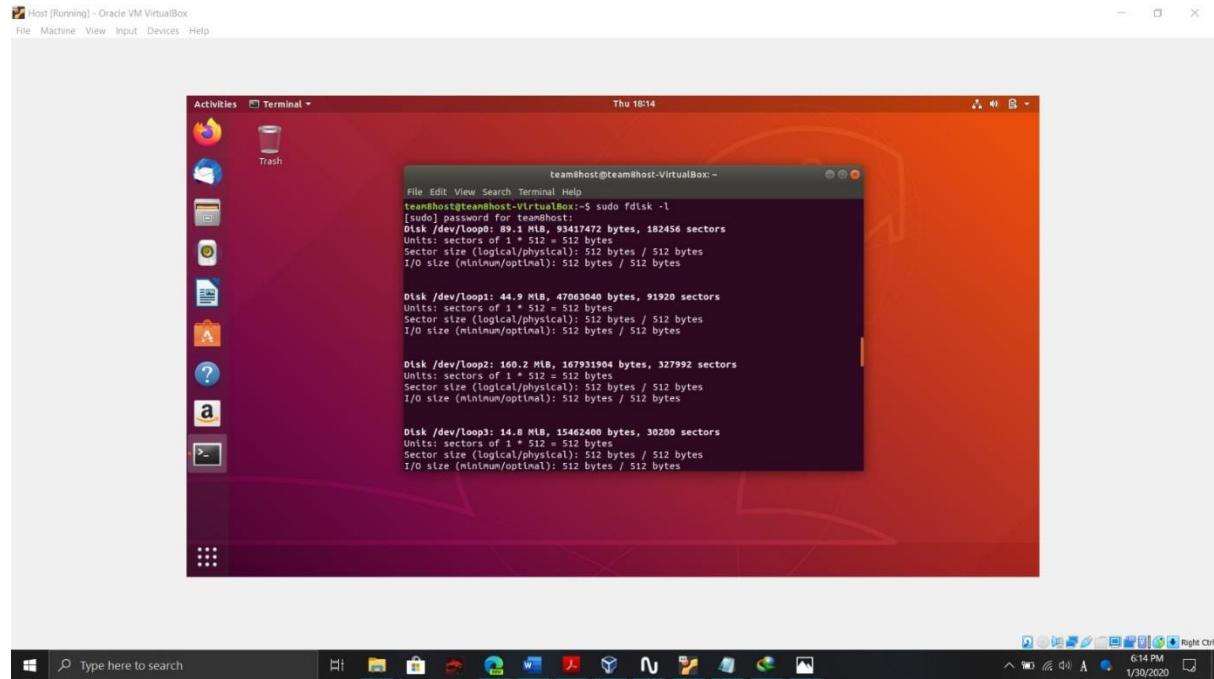
Q2 f.) ip – It gives information about the ip addresses of the system



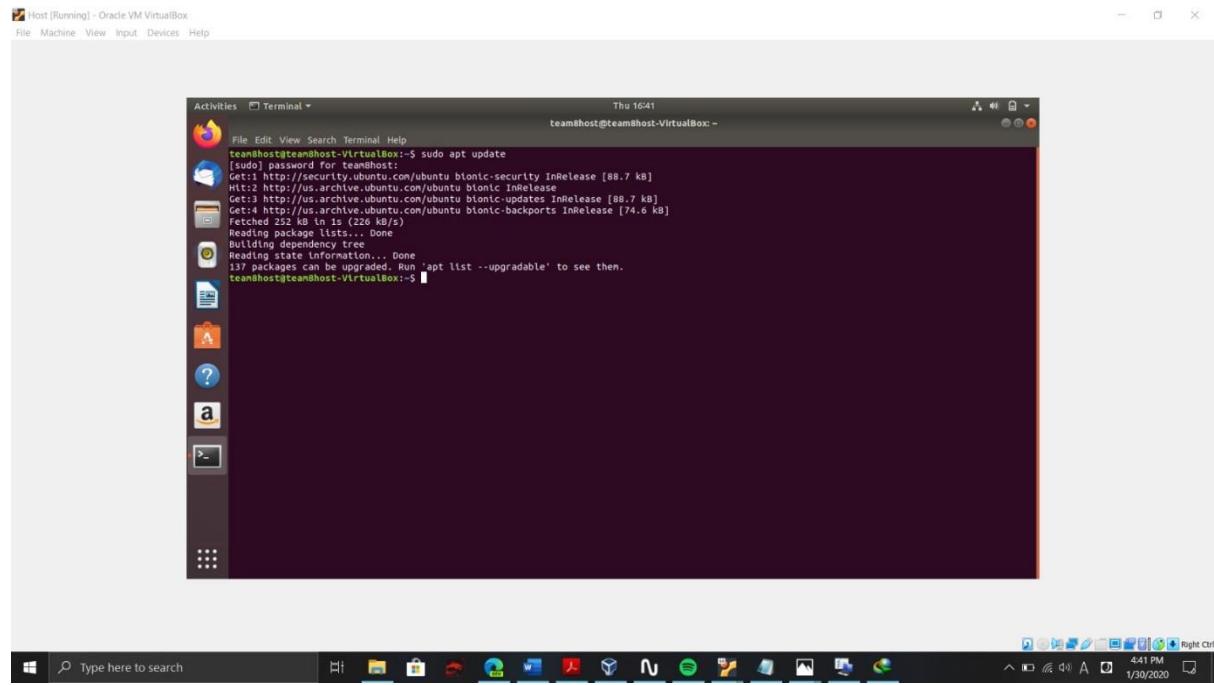
Q2 g.) dd – It lets you copy and convert a file. In the screenshot I have changed the input to uppercase



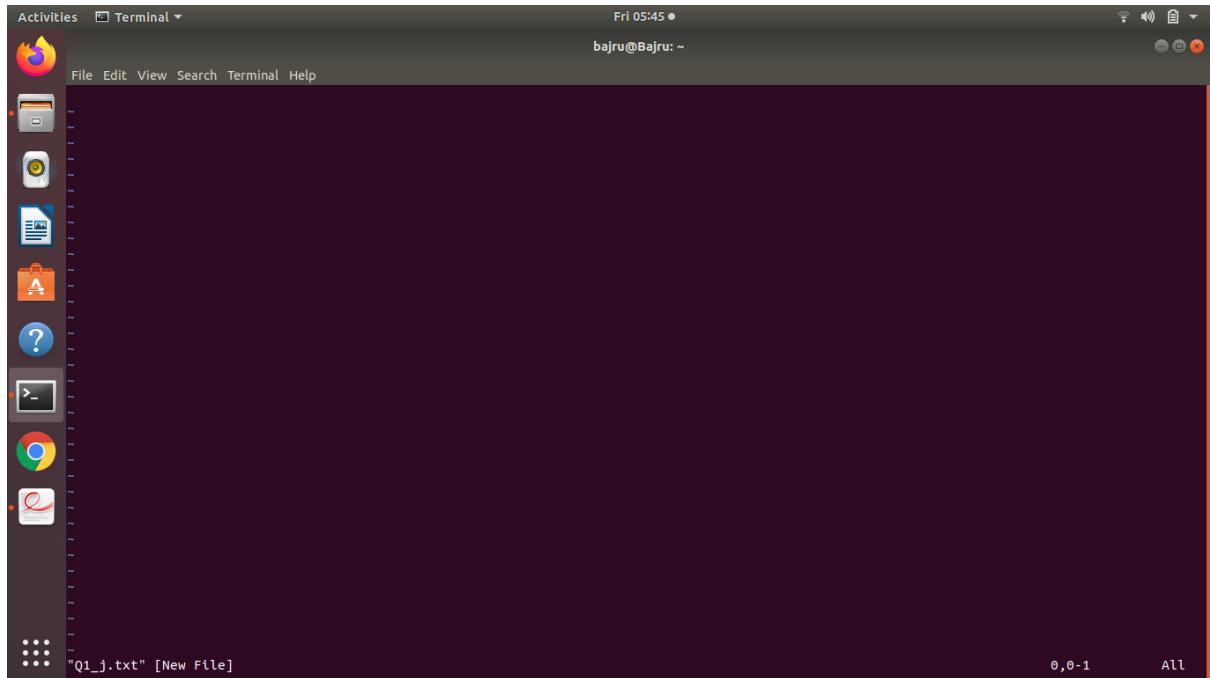
Q2 h.) fdisk – This helps in getting disk information



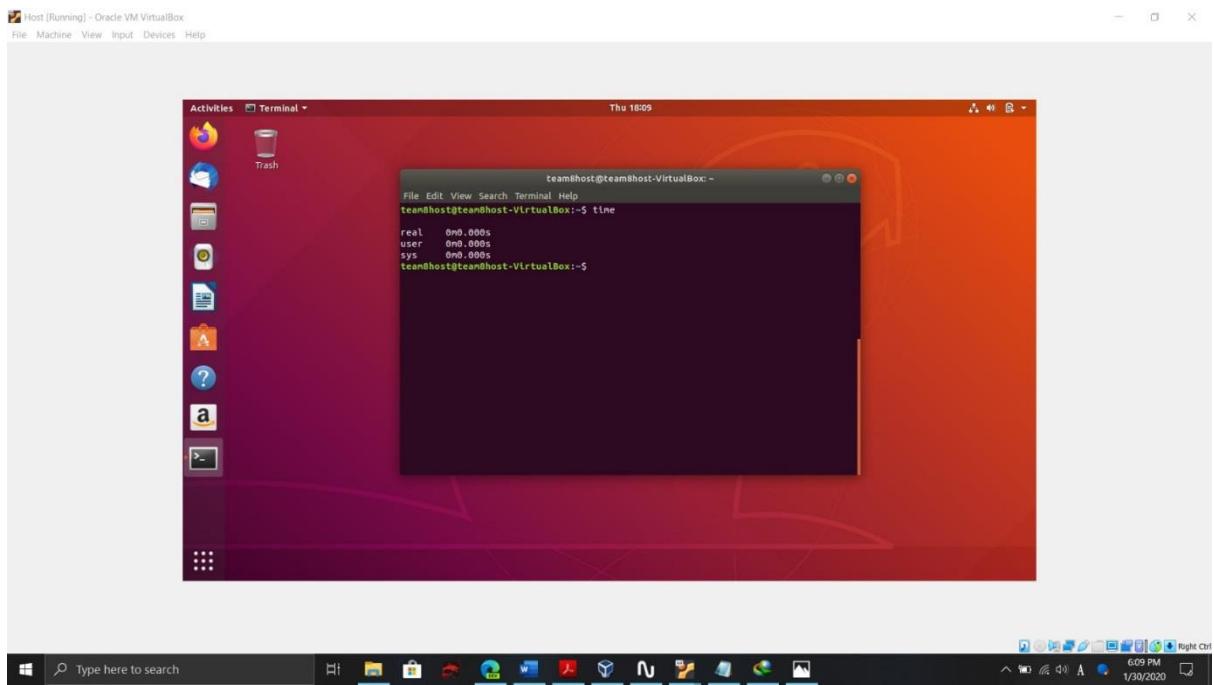
Q2 i.) apt – It is used to install or update packages



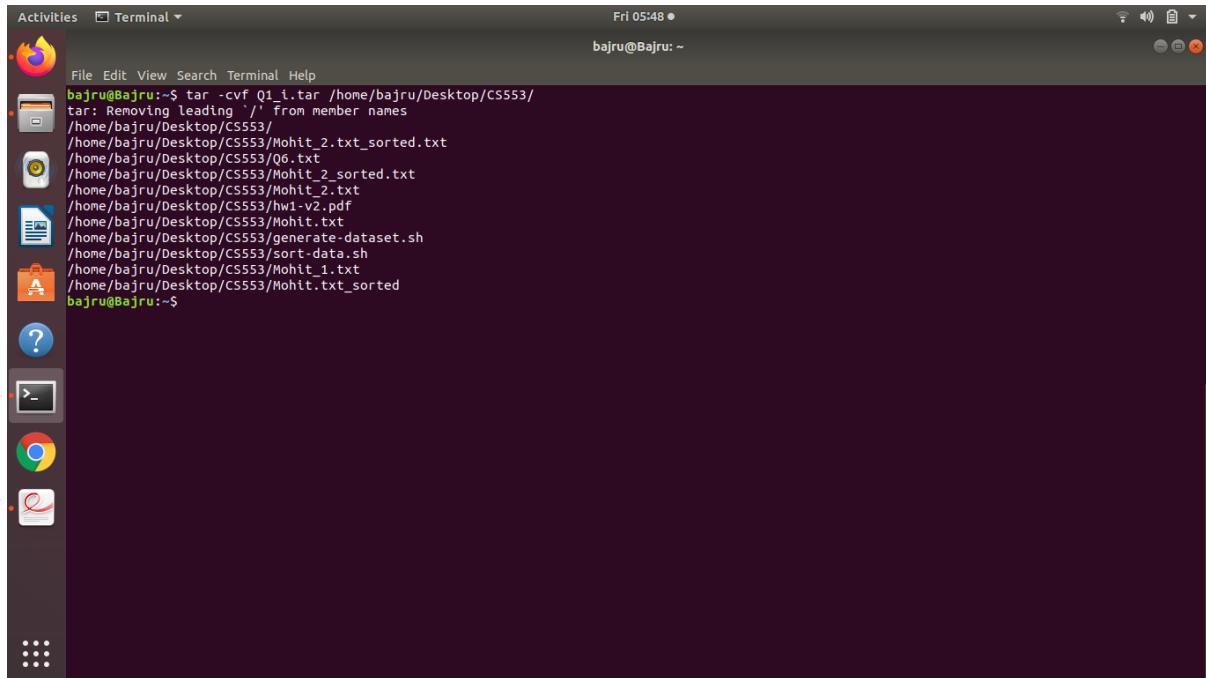
Q2 j.)



Q2 k.) time – Used to get the running time of a program



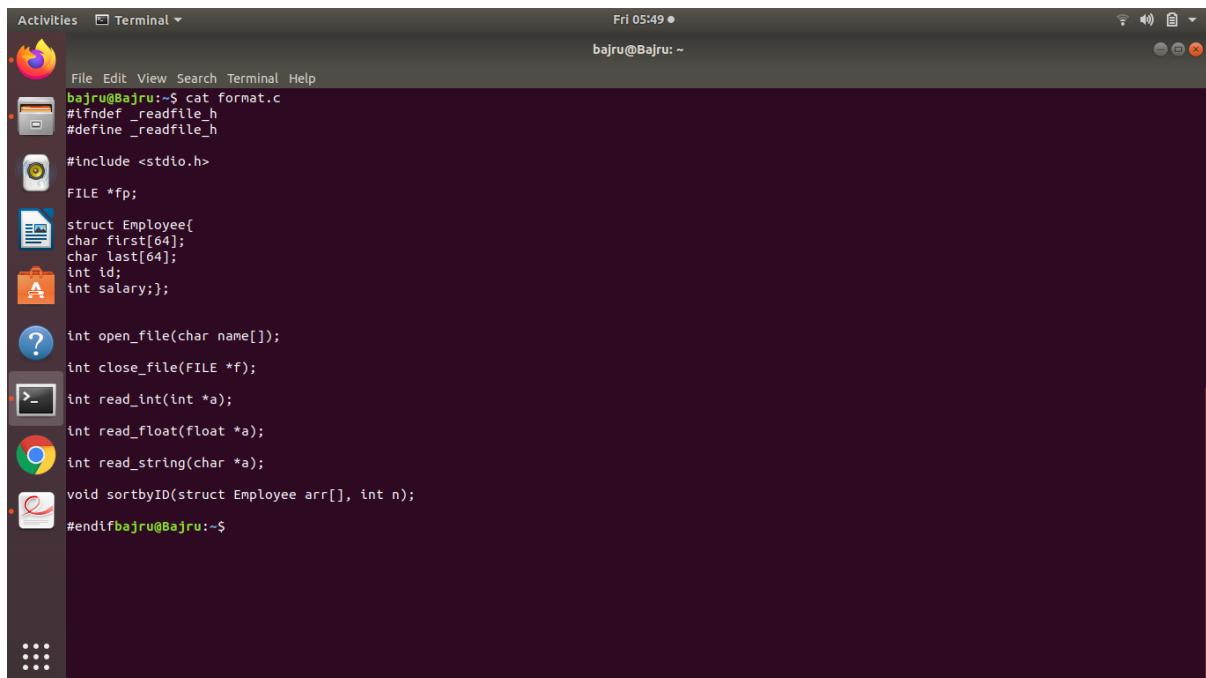
Q2 l.) tar – Used to perform operations related to compressing



A screenshot of an Ubuntu desktop environment. On the left is a dock with icons for the Dash, Home, Applications, and Help. The main area shows a terminal window titled "Activities Terminal". The terminal output is as follows:

```
File Edit View Search Terminal Help
bajru@Bajru:~$ tar -cvf Q1_i.tar /home/bajru/Desktop/CS553/
tar: Removing leading '/' from member names
/home/bajru/Desktop/CS553/
/home/bajru/Desktop/CS553/Mohit_2.txt_sorted.txt
/home/bajru/Desktop/CS553/Q6.txt
/home/bajru/Desktop/CS553/Mohit_2_sorted.txt
/home/bajru/Desktop/CS553/Mohit_2.txt
/home/bajru/Desktop/CS553/hw1-v2.pdf
/home/bajru/Desktop/CS553/Mohit.txt
/home/bajru/Desktop/CS553/generate-dataset.sh
/home/bajru/Desktop/CS553/sort-data.sh
/home/bajru/Desktop/CS553/Mohit_1.txt
/home/bajru/Desktop/CS553/Mohit.txt_sorted
bajru@Bajru:~$
```

Q2 m.) cat – It is used to read files sequentially and write them in the desired format



A screenshot of an Ubuntu desktop environment. On the left is a dock with icons for the Dash, Home, Applications, and Help. The main area shows a terminal window titled "Activities Terminal". The terminal output is as follows:

```
File Edit View Search Terminal Help
bajru@Bajru:~$ cat format.c
#ifndef _readfile_h
#define _readfile_h

#include <stdio.h>

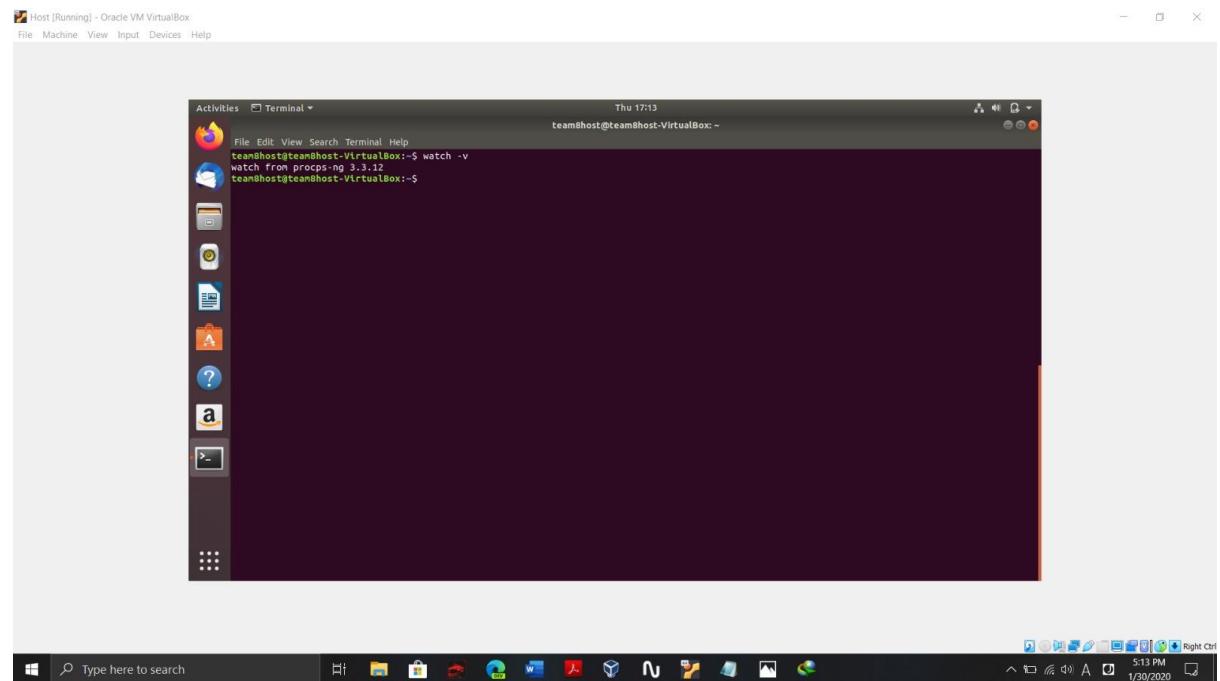
FILE *fp;

struct Employee{
    char first[64];
    char last[64];
    int id;
    int salary;};
}

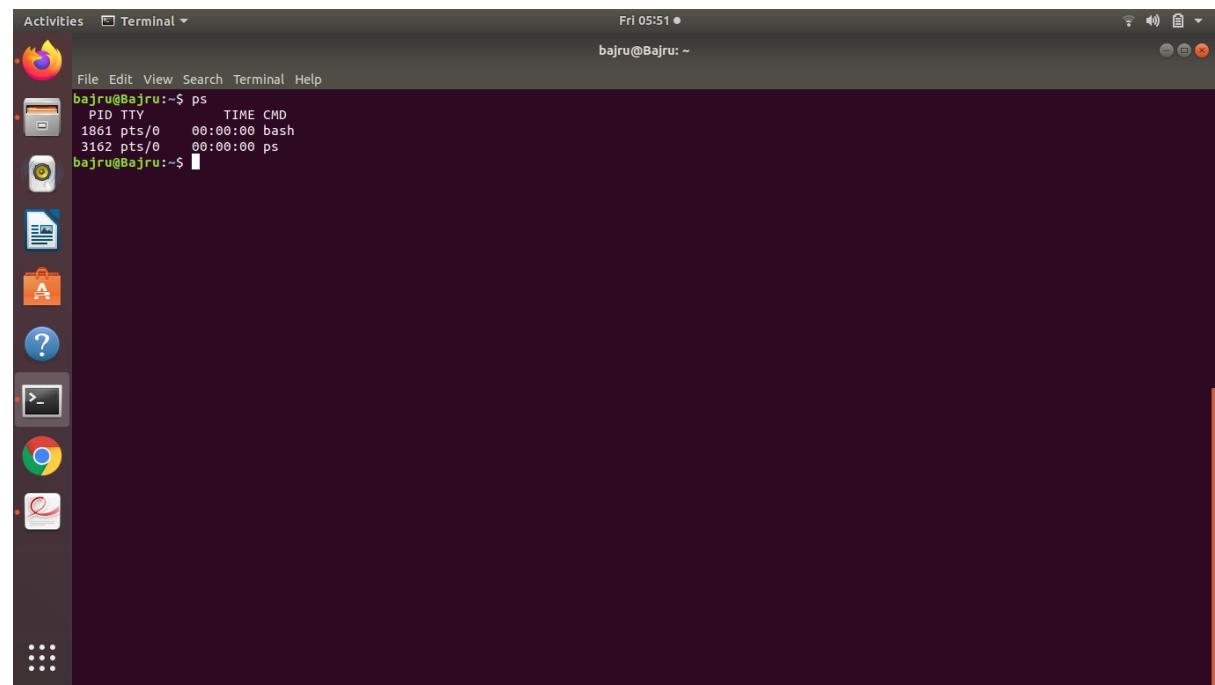
int open_file(char name[]);
int close_file(FILE *f);
int read_int(int *a);
int read_float(float *a);
int read_string(char *a);
void sortbyID(struct Employee arr[], int n);

#endif
bajru@Bajru:~$
```

Q2 n.) watch – It is used to run a program repeatedly and display the result at a user desired interval time



Q2 o.) ps – Shows a list of processes running



Q2 p.) top – It is the task manager for unix

```

Activities Terminal Fri 05:51 ● bajru@Bajru: ~
File Edit View Search Terminal Help
top - 05:51:44 up 11 min, 1 user, load average: 1.17, 1.40, 0.89
Tasks: 238 total, 1 running, 189 sleeping, 0 stopped, 0 zombie
%Cpu(s): 11.1 us, 2.6 sy, 0.1 ni, 79.5 id, 6.5 wa, 0.0 hi, 0.2 st, 0.0 st
KiB Mem : 3499572 total, 1080384 free, 1432808 used, 986384 buff/cache
KiB Swap: 2097148 total, 2097148 free, 0 used, 1759644 avail Mem
PID USER PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
23 root 20 0 0 0 0 I 5.6 0.0 0:01.23 kworker/2:0
870 root 20 0 269696 5816 5072 S 5.6 0.2 0:05.56 lio-sensor-prox
1448 bajru 20 0 3840596 174736 90860 S 5.6 5.0 0:55.71 gnome-shell
3175 bajru 20 0 51332 4024 3352 R 5.6 0.1 0:00.03 top
1 root 20 0 225608 9104 6476 S 0.0 0.3 0:03.17 systemd
2 root 20 0 0 0 S 0.0 0.0 0:00.01 kthreadd
5 root 20 0 0 0 0 I 0.0 0.0 0:00.20 kworker/u8:0
6 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 mm_percpu_wq
7 root 20 0 0 0 0 S 0.0 0.0 0:00.07 ksoftirqd/0
8 root 20 0 0 0 0 I 0.0 0.0 0:01.65 rcu_sched
9 root 20 0 0 0 0 I 0.0 0.0 0:00.00 rcu_bh
10 root rt 0 0 0 0 S 0.0 0.0 0:00.01 migration/0
11 root rt 0 0 0 0 S 0.0 0.0 0:00.00 watchdog/0
12 root 20 0 0 0 0 S 0.0 0.0 0:00.00 cpuhp/0
13 root 20 0 0 0 0 S 0.0 0.0 0:00.00 cpuhp/1
14 root rt 0 0 0 0 S 0.0 0.0 0:00.00 watchdog/1
15 root rt 0 0 0 0 S 0.0 0.0 0:00.00 migration/1
16 root 20 0 0 0 0 S 0.0 0.0 0:00.04 ksoftirqd/1
17 root 20 0 0 0 0 I 0.0 0.0 0:00.49 kworker/1:0
19 root 20 0 0 0 0 S 0.0 0.0 0:00.00 cpuhp/2
20 root rt 0 0 0 0 S 0.0 0.0 0:00.00 watchdog/2
21 root rt 0 0 0 0 S 0.0 0.0 0:00.00 migration/2
22 root 20 0 0 0 0 S 0.0 0.0 0:00.08 ksoftirqd/2
24 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/2:0:H
25 root 20 0 0 0 0 S 0.0 0.0 0:00.00 cpuhp/3
26 root rt 0 0 0 0 S 0.0 0.0 0:00.00 watchdog/3
27 root rt 0 0 0 0 S 0.0 0.0 0:00.00 migration/3
28 root 20 0 0 0 0 S 0.0 0.0 0:00.13 ksoftirqd/3
29 root 20 0 0 0 0 I 0.0 0.0 0:00.00 kworker/3:0
31 root 20 0 0 0 0 S 0.0 0.0 0:00.00 kdevtmpfs

```

Q2 q.) htop – It is an interactive process viewer for unix systems

```

Activities Terminal Fri 05:52 ● bajru@Bajru: ~
File Edit View Search Terminal Help
1 [ ] Tasks: 141, 498 thr; 1 running
2 [ ] Load average: 1.49 1.43 0.93
3 [ ] Uptime: 00:11:53
4 [ ]
Mem[|||||] 1.42G/3.34G
Swap[ ] 0K/2.00G
PID USER PRI NI VIRT RES SHR S %CPU %MEM TIME+ Command
3526 bajru 20 0 40952 5000 3844 R 2.0 0.1 0:00.14 htop
1856 bajru 20 0 554M 42324 31152 S 1.3 1.2 0:04.74 /usr/lib/gnome-terminal/gnome-terminal-server
870 root 20 0 263M 5816 5072 D 0.7 0.2 0:05.99 /usr/sbin/lio-sensor-proxy
1448 bajru 20 0 3754M 170M 90860 S 0.7 5.0 0:59.54 /usr/bin/gnome-shell
2343 bajru 20 0 2621M 149M 87460 S 0.7 4.4 0:00.20 /usr/lib/firefox/firefox -contentproc -childID 3 -isForBrowser -prefsLen 6253 -
2329 bajru 20 0 2621M 149M 87460 S 0.7 4.4 0:09.61 /usr/lib/firefox/firefox -contentproc -childID 3 -isForBrowser -prefsLen 6253 -
1 root 20 0 230M 9104 6476 S 0.0 0.3 0:03.19 /sbin/init splash
284 root 19 -1 95228 15060 13968 S 0.0 0.4 0:00.58 /lib/systemd/systemd-journald
306 root 20 0 47548 5792 3124 S 0.0 0.2 0:01.89 /lib/systemd/systemd-udev
822 systemd-t 20 0 142M 3312 2748 S 0.0 0.1 0:00.00 /lib/systemd/systemd-timesyncd
819 systemd-t 20 0 142M 3312 2748 S 0.0 0.1 0:00.08 /lib/systemd/systemd-timesyncd
820 systemd-r 20 0 70840 6244 5428 S 0.0 0.2 0:00.37 /lib/systemd/systemd-resolved
834 root 20 0 107M 3392 3068 S 0.0 0.1 0:00.00 /usr/sbin/lrqbalance --foreground
824 root 20 0 107M 3392 3068 S 0.0 0.1 0:00.05 /usr/sbin/lrqbalance --foreground
835 root 20 0 491M 11992 8676 S 0.0 0.3 0:00.00 /usr/lib/udisks2/udisksd
889 root 20 0 491M 11992 8676 S 0.0 0.3 0:00.01 /usr/lib/udisks2/udisksd
904 root 20 0 491M 11992 8676 S 0.0 0.3 0:00.00 /usr/lib/udisks2/udisksd
911 root 20 0 491M 11992 8676 S 0.0 0.3 0:00.00 /usr/lib/udisks2/udisksd
827 root 20 0 491M 11992 8676 S 0.0 0.3 0:00.43 /usr/lib/udisks2/udisksd
829 root 20 0 70728 6120 5320 S 0.0 0.2 0:00.63 /lib/systemd/systemd-logind
831 avahi 20 0 47264 3220 2884 S 0.0 0.1 0:00.16 avahi-daemon: running [Bajru.local]
836 avahi 20 0 47080 336 0 S 0.0 0.0 0:00.00 avahi-daemon: chroot helper
892 root 20 0 424M 9432 7992 S 0.0 0.3 0:00.00 /usr/sbin/ModemManager --filter-policy=strict
895 root 20 0 424M 9432 7992 S 0.0 0.3 0:00.01 /usr/sbin/ModemManager --filter-policy=strict
837 root 20 0 424M 9432 7992 S 0.0 0.3 0:00.10 /usr/sbin/ModemManager --filter-policy=strict
923 root 20 0 1491M 28776 14112 S 0.0 0.8 0:00.07 /usr/lib/snaps/snapsd
924 root 20 0 1491M 28776 14112 S 0.0 0.8 0:00.00 /usr/lib/snaps/snapsd
F1 Help F2 Setup F3 Search F4 Filter F5 Tree F6 Sort By F7 Slice F8 Nice F9 Kill F10 Quit

```

Q2 r.) gcc – It is used to run C programs

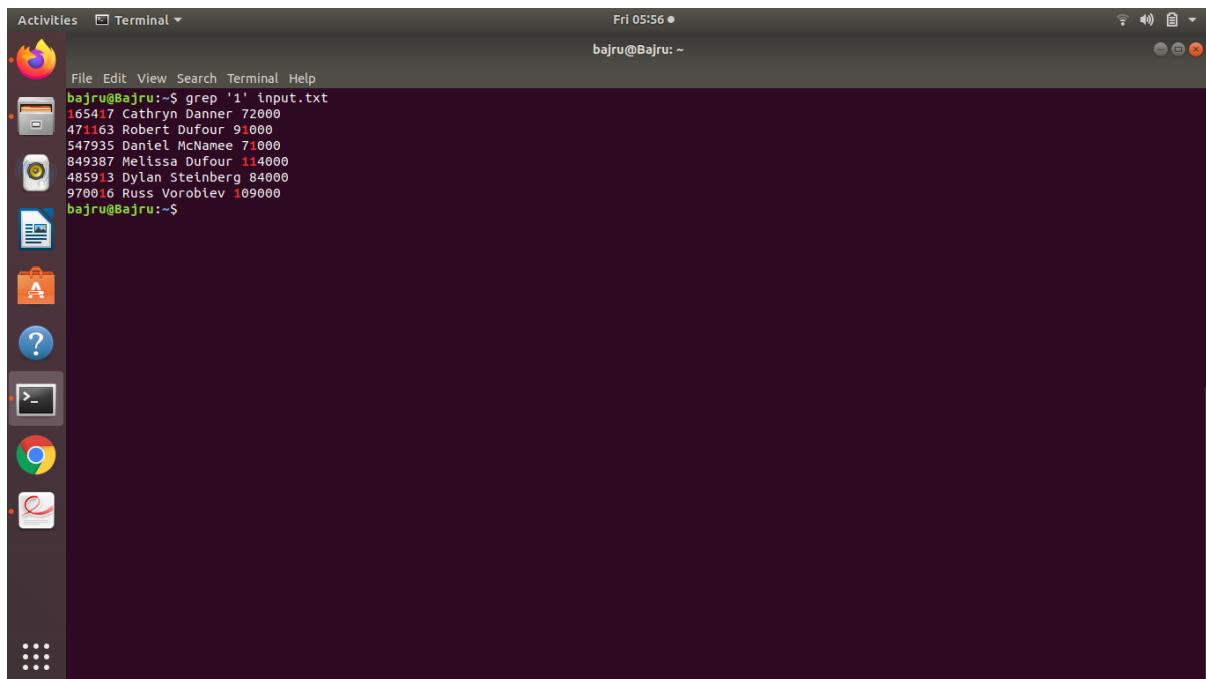
A screenshot of a Linux desktop environment, likely Ubuntu, showing a terminal window. The terminal window is titled "Terminal" and has the following content:

```
bajru@Bajru:~$ gcc format.c  
/usr/lib/gcc/x86_64-linux-gnu/7/../../../../x86_64-linux-gnu/scri1.o: In function `__start':  
.text+0x20): undefined reference to `main'  
collect2: error: ld returned 1 exit status  
bajru@Bajru:~$
```

The desktop interface includes a dock on the left with icons for various applications like a file manager, terminal, and system settings. The top bar shows the date and time as "Fri 05:53" and the user as "bajru@Bajru".

Q2 s.) tail – It is used to display the end data of a file

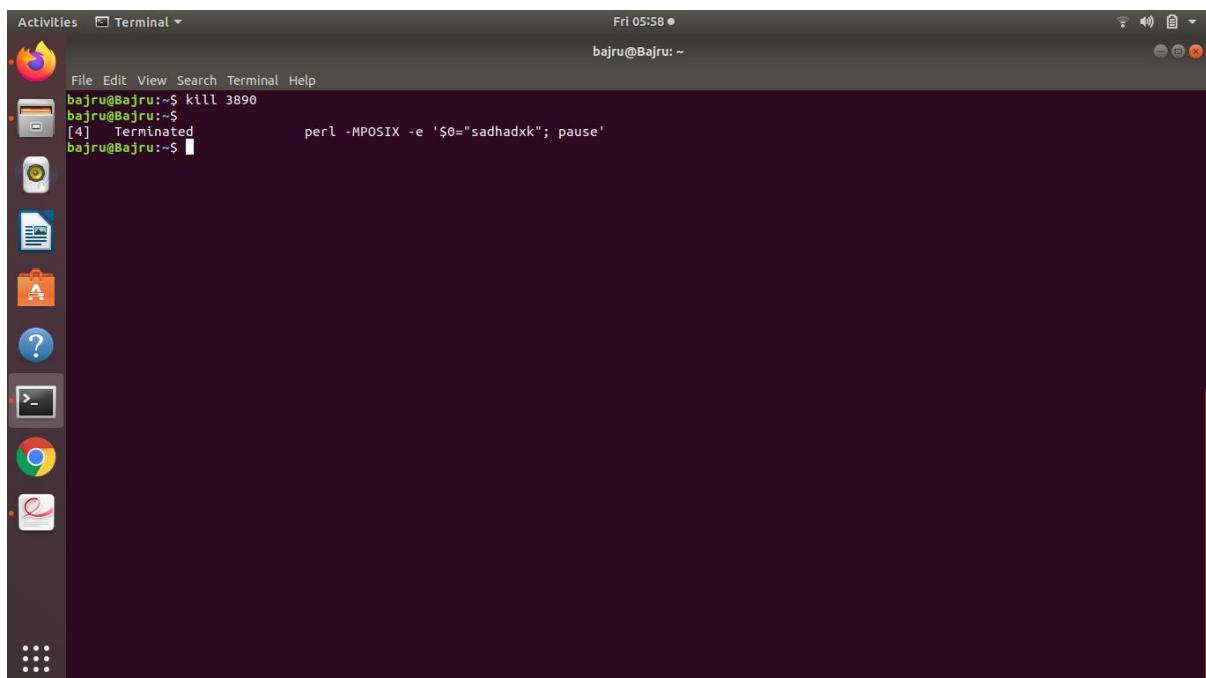
Q2 t.) grep – used to search information in a file



A screenshot of an Ubuntu desktop environment. On the left is a dock with icons for Dash, Home, Applications, Help, and others. A terminal window titled "Terminal" is open in the center. The terminal shows the command "grep '1' input.txt" and its output, which lists several names and IDs from a file. The system tray at the top right shows the date and time as "Fri 05:56".

```
File Edit View Search Terminal Help
bajru@Bajru:~$ grep '1' input.txt
165417 Cathryn Danner 72000
471163 Robert Dufour 91000
547935 Daniel McNamee 71000
849387 Melissa Dufour 114000
485913 Dylan Steinberg 84000
970016 Russ Voroblev 109000
bajru@Bajru:~$
```

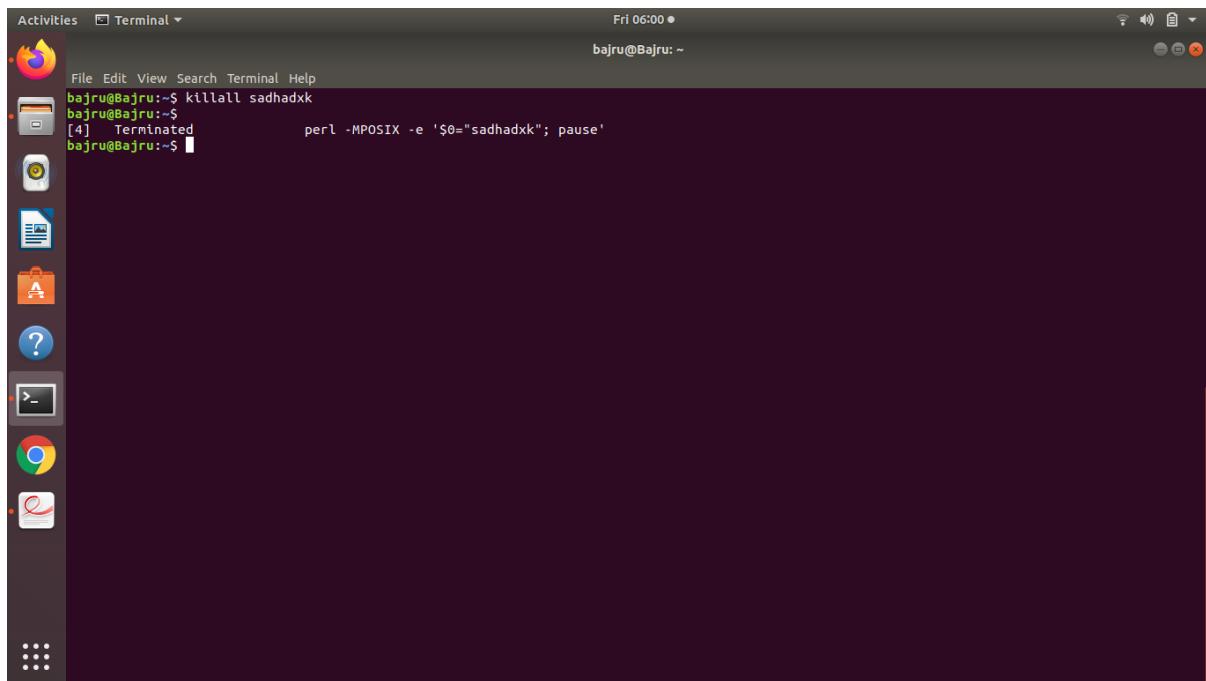
Q2 u.) kill – Used to kill the process



A screenshot of an Ubuntu desktop environment, identical to the one above. A terminal window titled "Terminal" is open, showing the command "kill 3890" and its output. It indicates that process [4] has terminated. The system tray at the top right shows the date and time as "Fri 05:58".

```
File Edit View Search Terminal Help
bajru@Bajru:~$ kill 3890
bajru@Bajru:~$
[4]  Terminated                  perl -MPOSIX -e '$0="sadhadxk"; pause'
bajru@Bajru:~$
```

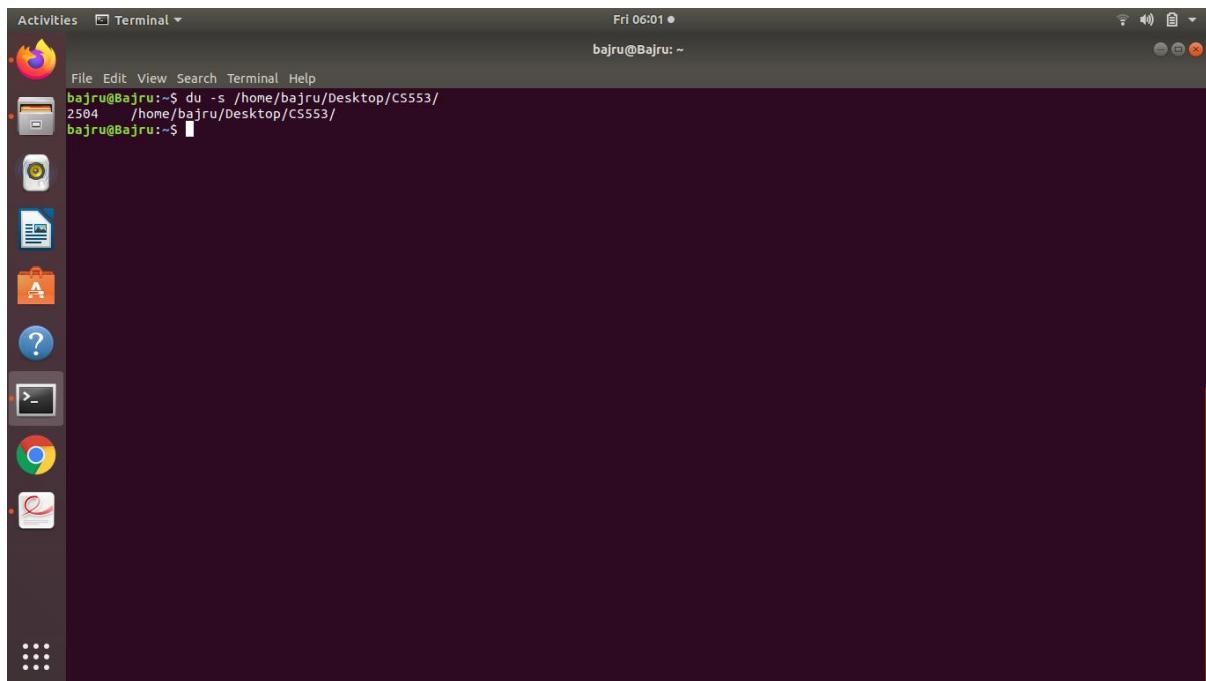
Q2 v.) killall – used to kill a process using it's name



A screenshot of an Ubuntu desktop environment. On the left is a vertical dock with icons for various applications: Dash, Home, Dash search, Activities overview, Applications, Help, Terminal, and others. The main area shows a terminal window titled "Terminal". The terminal output is as follows:

```
File Edit View Search Terminal Help
bajru@Bajru:~$ killall sadhadxk
bajru@Bajru:~$ [4] Terminated perl -MPOSIX -e '$0="sadhadxk"; pause'
bajru@Bajru:~$
```

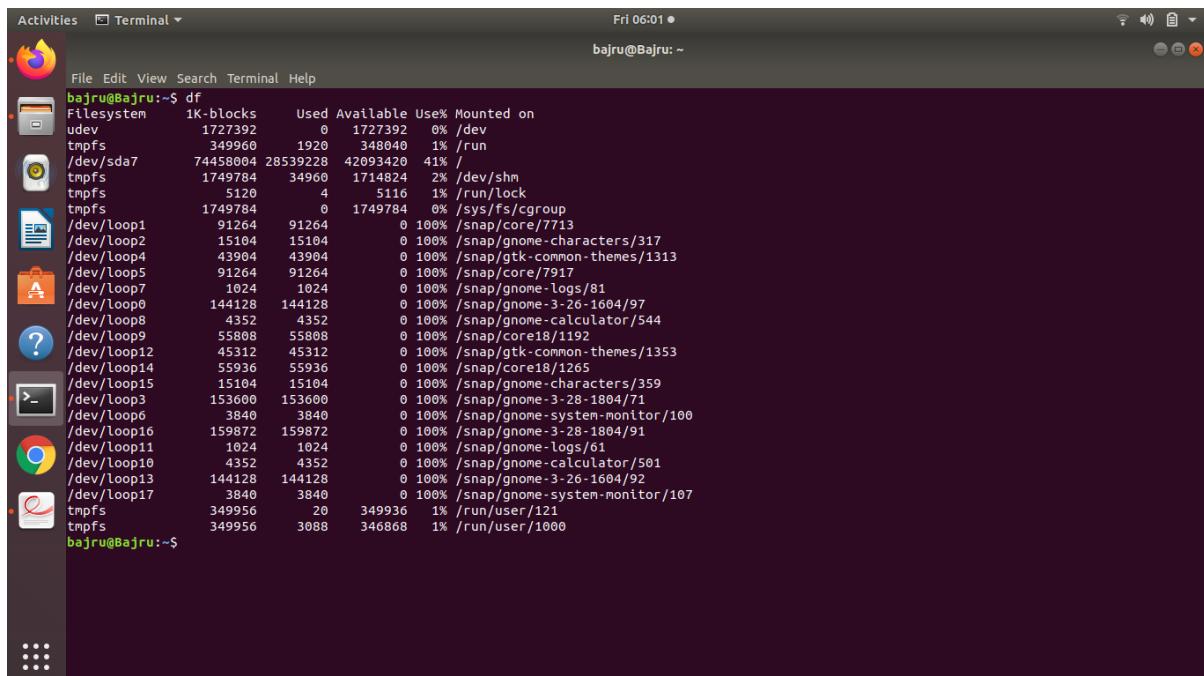
Q2 w.) du – used to show the disk usage



A screenshot of an Ubuntu desktop environment, similar to the previous one. The terminal window shows the following output:

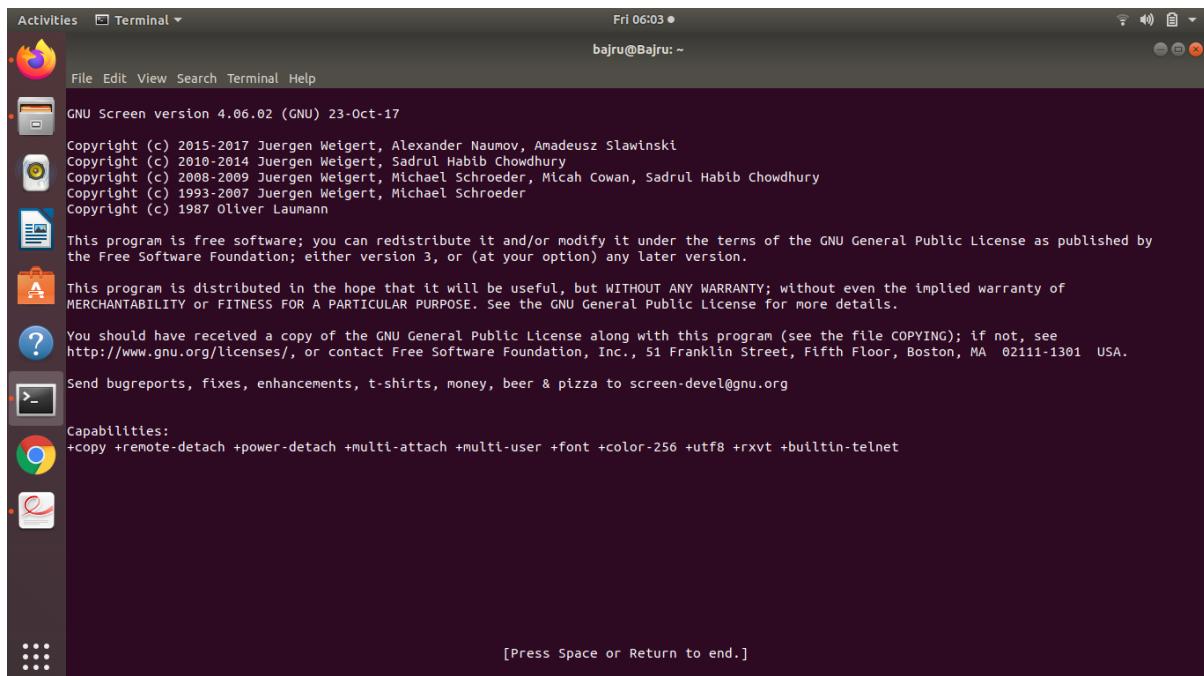
```
File Edit View Search Terminal Help
bajru@Bajru:~$ du -s /home/bajru/Desktop/CS553/
2504 /home/bajru/Desktop/CS553/
bajru@Bajru:~$
```

Q2 x.) df – it is used to show the available space on disk systems



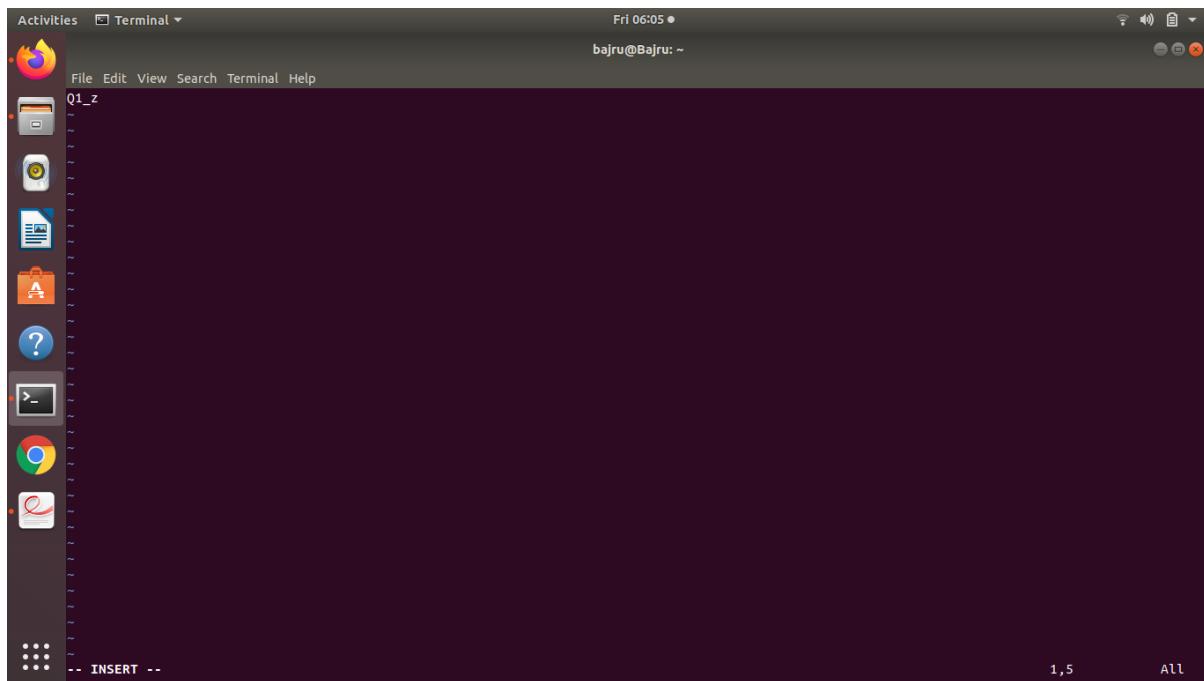
```
Activities Terminal Fri 06:01 ● bajru@Bajru: ~
File Edit View Search Terminal Help
bajru@Bajru:~$ df
Filesystem 1K-blocks Used Available Use% Mounted on
udev 1727392 0 1727392 0% /dev
tmpfs 349960 1920 348040 1% /run
/dev/sda7 74458004 28539228 42093420 41% /
tmpfs 1749784 34960 1714824 2% /dev/shm
tmpfs 5120 4 5116 1% /run/lock
tmpfs 1749784 0 1749784 0% /sys/fs/cgroup
/dev/loop1 91264 91264 0 100% /snap/core/7713
/dev/loop2 15104 15104 0 100% /snap/gnome-characters/317
/dev/loop4 43904 43904 0 100% /snap/gtk-common-themes/1313
/dev/loop5 91264 91264 0 100% /snap/core/7917
/dev/loop7 1024 1024 0 100% /snap/gnome-logs/81
/dev/loop0 144128 144128 0 100% /snap/gnome-3-26-1604/97
/dev/loop8 4352 4352 0 100% /snap/gnome-calculator/544
/dev/loop9 55808 55808 0 100% /snap/core18/1192
/dev/loop12 45312 45312 0 100% /snap/gtk-common-themes/1353
/dev/loop14 55936 55936 0 100% /snap/core18/1265
/dev/loop15 15104 15104 0 100% /snap/gnome-characters/359
/dev/loop3 153600 153600 0 100% /snap/gnome-3-28-1804/71
/dev/loop6 3840 3840 0 100% /snap/gnome-system-monitor/100
/dev/loop16 159872 159872 0 100% /snap/gnome-3-28-1804/91
/dev/loop11 1024 1024 0 100% /snap/gnome-logs/81
/dev/loop10 4352 4352 0 100% /snap/gnome-calculator/501
/dev/loop13 144128 144128 0 100% /snap/gnome-3-26-1604/92
/dev/loop17 3840 3840 0 100% /snap/gnome-system-monitor/107
tmpfs 349956 20 349936 1% /run/user/121
tmpfs 349956 3088 346868 1% /run/user/1000
bajru@Bajru:~$
```

Q2 y.) screen – It allows user to access multiple login sessions inside a single terminal

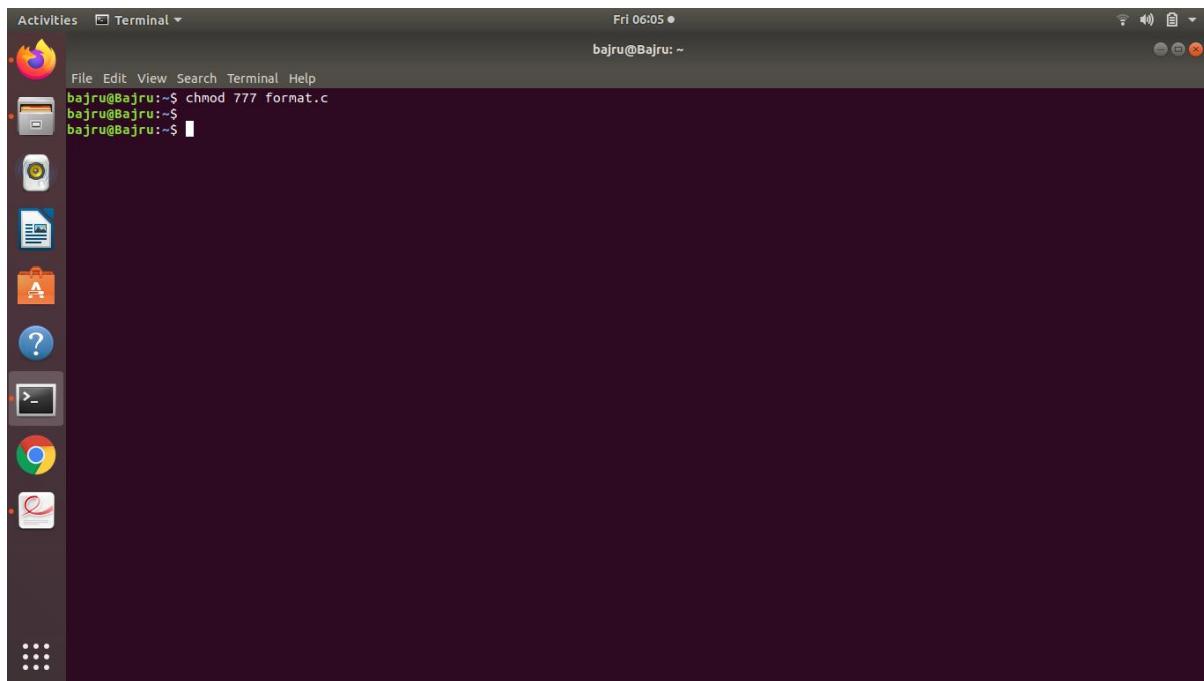


```
Activities Terminal Fri 06:03 ● bajru@Bajru: ~
File Edit View Search Terminal Help
GNU Screen version 4.06.02 (GNU) 23-Oct-17
Copyright (c) 2015-2017 Juergen Weigert, Alexander Naumov, Amadeusz Slawinski
Copyright (c) 2010-2014 Juergen Weigert, Sadrul Habib Chowdhury
Copyright (c) 2008-2009 Juergen Weigert, Michael Schroeder, Micah Cowan, Sadrul Habib Chowdhury
Copyright (c) 1993-2007 Juergen Weigert, Michael Schroeder
Copyright (c) 1987 Oliver Laumann
This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 3, or (at your option) any later version.
This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.
You should have received a copy of the GNU General Public License along with this program (see the file COPYING); if not, see http://www.gnu.org/licenses/, or contact Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02111-1301 USA.
Send bugreports, fixes, enhancements, t-shirts, money, beer & pizza to screen-devel@gnu.org
Capabilities:
+copy +remote-detach +power-detach +multi-attach +multi-user +font +color-256 +utf8 +rxvt +builtin-telnet
[Press Space or Return to end.]
```

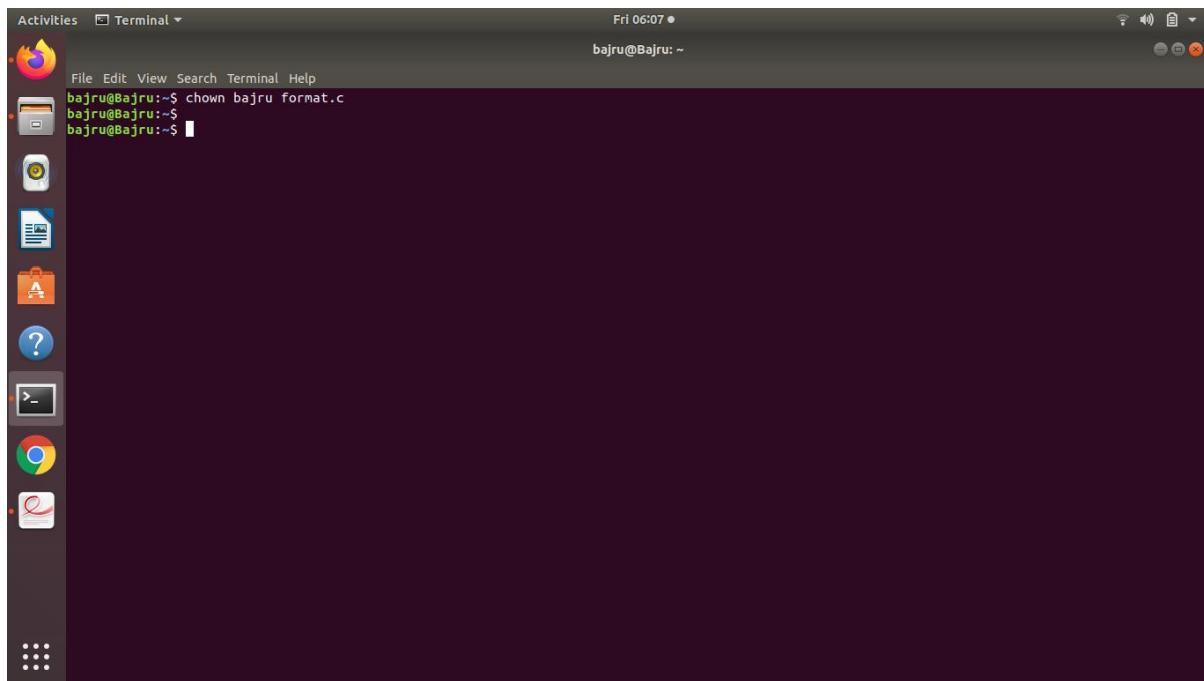
Q2 z.) vim – This is a text editor



Q2 aa.) chmod – Used to change permissions of a file or folder



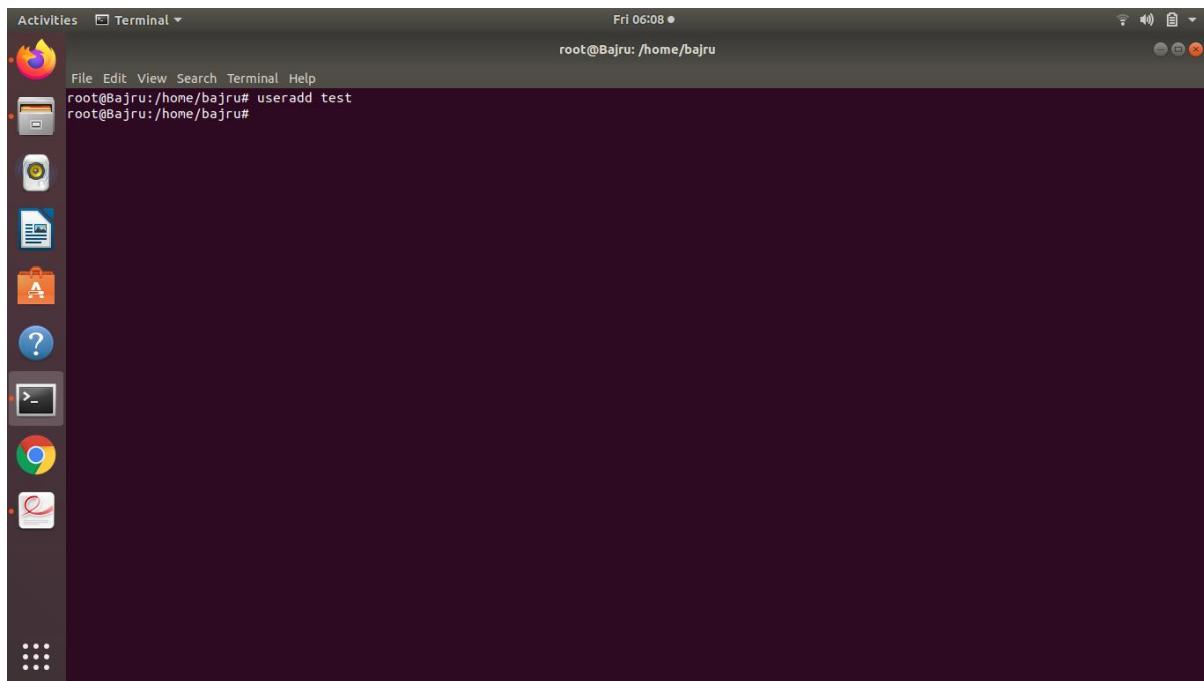
Q2 bb.) chown – used to change the owner or group of a file or folder



A screenshot of an Ubuntu desktop environment. On the left is a vertical dock with icons for various applications like Dash, Home, Dash to Dock, Help, and others. In the center is a terminal window titled "Terminal". The terminal shows the following command history:

```
Activities Terminal Fri 06:07 ● bajru@Bajru: ~
bajru@Bajru:~$ chown bajru format.c
bajru@Bajru:~$ bajru@Bajru:~$
```

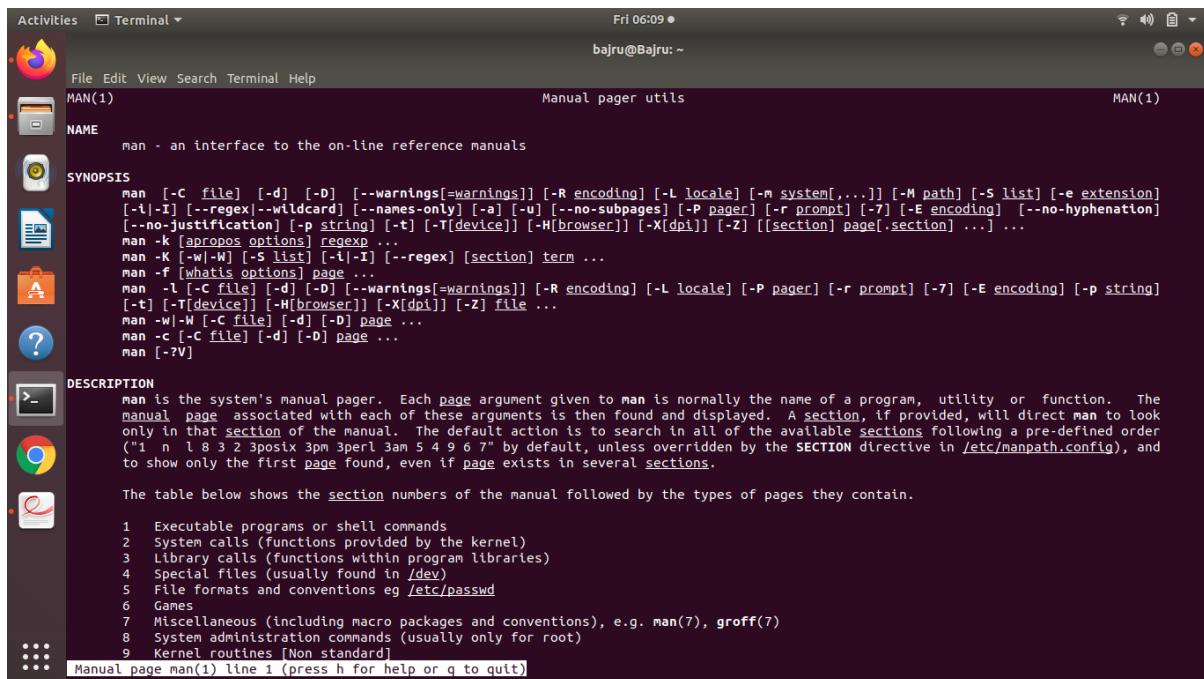
Q2 cc.) useradd – used to create a new user



A screenshot of an Ubuntu desktop environment. On the left is a vertical dock with icons for Dash, Home, Dash to Dock, Help, and others. In the center is a terminal window titled "Terminal". The terminal shows the following command history:

```
Activities Terminal Fri 06:08 ● root@Bajru: /home/bajru
root@Bajru:/home/bajru# useradd test
root@Bajru:/home/bajru#
```

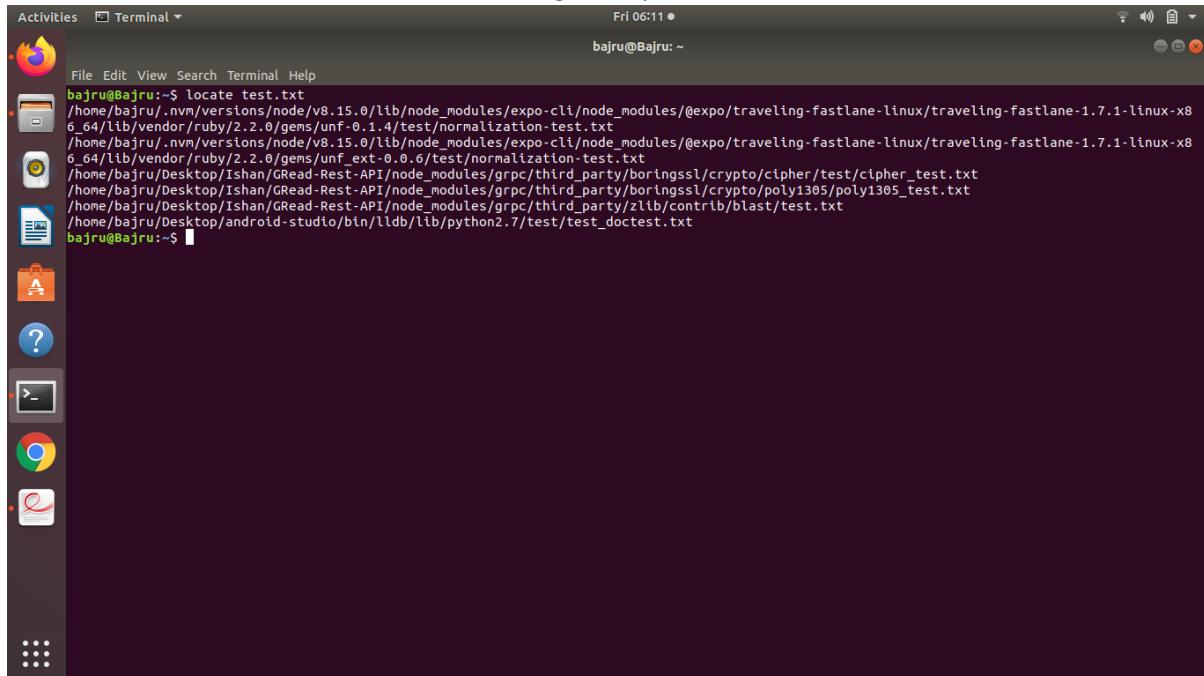
Q2 dd.) man – used to give information about various commands



The screenshot shows a terminal window titled "Terminal" with the command "man(1)" entered. The output is the "Manual pager utils" page. It includes sections for NAME, SYNOPSIS, and DESCRIPTION, along with a table of section numbers and their corresponding types.

```
Fri 06:09 • bajru@Bajru: ~
File Edit View Search Terminal Help
MAN(1) Manual pager utils MAN(1)
NAME
    man - an interface to the on-line reference manuals
SYNOPSIS
    man [-C file] [-d] [--warnings[=warnings]] [-R encoding] [-L locale] [-m system[,...]] [-M path] [-S list] [-e extension]
    [-i|-I] [--regex|--wildcard] [--names-only] [-a] [-u] [-no-subpages] [-P pager] [-r prompt] [-7] [-E encoding] [--no-hyphenation]
    [-no-justification] [-p string] [-t] [-T[device]] [-H[browser]] [-X[dpi]] [-Z] [[section] page[.section] ...] ...
    man - [apropos options] regexp ...
    man -K [-wl-W] [-S list] [-i|-I] [-regex] [section] term ...
    man -f [whatis options] page ...
    man -l [-C file] [-d] [-D] [--warnings[=warnings]] [-R encoding] [-L locale] [-P pager] [-r prompt] [-7] [-E encoding] [-p string]
    [-t] [-T[device]] [-H[browser]] [-X[dpi]] [-Z] file ...
    man -w|-W [-C file] [-d] [-D] page ...
    man -c [-C file] [-d] [-D] page ...
    man [-?V]
DESCRIPTION
    man is the system's manual pager. Each page argument given to man is normally the name of a program, utility or function. The
    manual page associated with each of these arguments is then found and displayed. A section, if provided, will direct man to look
    only in that section of the manual. The default action is to search in all of the available sections following a pre-defined order
    ("1 n l 8 3 2 3postx 3pm 3perl 3am 5 4 9 6 7" by default, unless overridden by the SECTION directive in /etc/manpath.config), and
    to show only the first page found, even if page exists in several sections.
    The table below shows the section numbers of the manual followed by the types of pages they contain.
    1 Executable programs or shell commands
    2 System calls (functions provided by the kernel)
    3 Library calls (functions within program libraries)
    4 Special files (usually found in /dev)
    5 File formats and conventions eg /etc/passwd
    6 Games
    7 Miscellaneous (including macro packages and conventions), e.g. man(7), groff(7)
    8 System administration commands (usually only for root)
    9 Kernel routines [Non standard].
Manual page man(1) line 1 (press h for help or q to quit)
```

Q2 ee.) locate – used to locate a file containing the input text in its name



The screenshot shows a terminal window titled "Terminal" with the command "locate test.txt" entered. The output lists several file paths containing "test.txt".

```
Fri 06:11 • bajru@Bajru: ~
File Edit View Search Terminal Help
bajru@bajru:~$ locate test.txt
/home/bajru/.nvm/versions/node/v8.15.0/lib/node_modules/expo-cli/node_modules/@expo/traveling-fastlane-linux/traveling-fastlane-1.7.1-linux-x8
6_64/lib/vendor/ruby/2.2.0/gems/unf-0.1.4/test/normalization-test.txt
/home/bajru/.nvm/versions/node/v8.15.0/lib/node_modules/expo-cli/node_modules/@expo/traveling-fastlane-linux/traveling-fastlane-1.7.1-linux-x8
6_64/lib/vendor/ruby/2.2.0/gems/unf_ext-0.0.6/test/normalization-test.txt
/home/bajru/Desktop/Ishan/Gread-Rest-API/node_modules/grpc/third_party/boringssl/crypto/cipher/test/cipher_test.txt
/home/bajru/Desktop/Ishan/Gread-Rest-API/node_modules/grpc/third_party/boringssl/crypto/poly1305/poly1305_test.txt
/home/bajru/Desktop/Ishan/Gread-Rest-API/node_modules/grpc/third_party/zlib/contrib/blast/test.txt
/home/bajru/Desktop/android-studio/bin/lldb/lib/python2.7/test/test_doctest.txt
bajru@bajru:~$
```

Q2 ff.) find – used to find the file with the input name

Q2 gg.) sed – It is used to parse and transform text

```
Activities Terminal Fri 06:13 ●
bajru@Bajru:~ File Edit View Search Terminal Help
bajru@Bajru:~$ sed 's/char/test/' format.c
#ifndef _readfile_h
#define _readfile_h

#include <stdio.h>
FILE *fp;

struct Employee{
    test first[64];
    test last[64];
    int id;
    int salary;};

int open_file(test name[]);
int close_file(FILE *f);
int read_int(int *a);
int read_float(float *a);
int read_string(test *a);
void sortbyID(struct Employee arr[], int n);

#endif bajru@Bajru:~$
```

Q2 hh.) awk – It is used to manipulate data and generate reports

A screenshot of a Linux desktop environment, likely elementary OS, showing a terminal window. The terminal window is titled "Terminal" and has the command "awk '/char/' format.c" entered. The output of the command is displayed below:

```
bajru@Bajru:~$ awk '/char/' format.c
char first[64];
char last[64];
int open_file(char name[]);
int read_string(char *a);
bajru@Bajru:~$
```

The desktop interface includes a dock on the left with icons for various applications like a file manager, terminal, browser, and email. The top bar shows the date and time as "Fri 06:14" and the user as "bajru@Bajru".

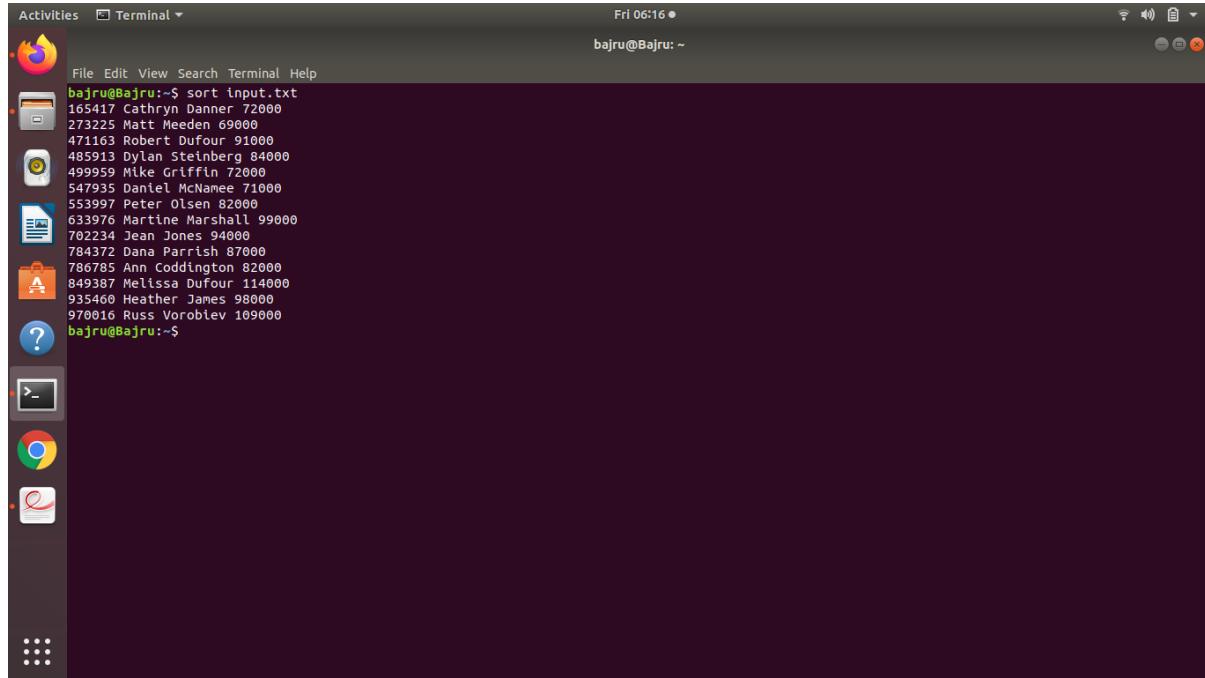
Q2 ii.) diff – Used to find difference between two files



Activities Terminal Fri 06:15 bajru@Bajru: ~

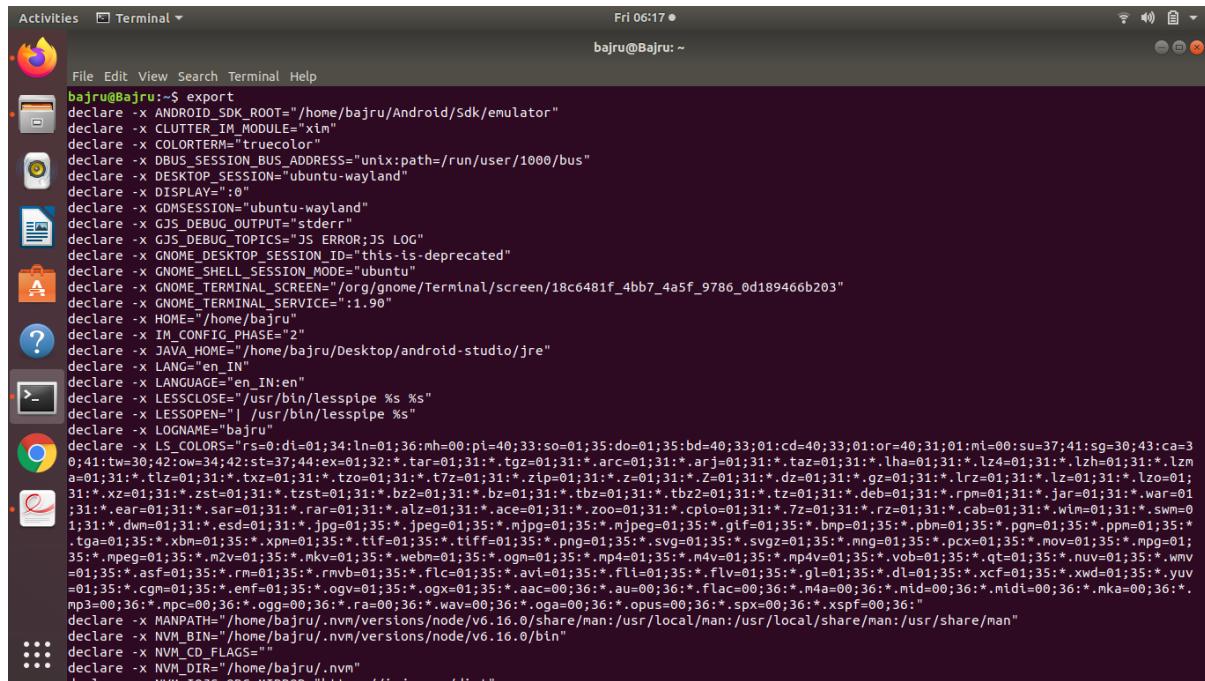
```
bajru@Bajru:~$ diff input.txt format.c
1,14c1,27
< 165417 Cathryn Danner 72000
< 273225 Matt Meeden 69000
< 633976 Martine Marshall 99000
< 471163 Robert Dufour 91000
< 499959 Mike Griffin 72000
< 547935 Daniel McNamee 71000
< 553997 Peter Olsen 82000
< 702234 Jean Jones 94000
< 784372 Dana Parrish 87000
< 786785 Ann Coddington 82000
< 849387 Melissa Dufour 114000
< 485913 Dylan Stenberg 84000
< 935460 Heather James 98000
< 970616 Russ Vorobiev 109000
---
> #ifndef _readfile_h
> #define _readfile_h
>
> #include <stdio.h>
>
> FILE *fp;
>
> struct Employee{
> char first[64];
> char last[64];
> int id;
> int salary;};
>
>
> int open_file(char name[]);
>
> int close_file(FILE *f);
>
> int read_int(int *a);
>
>     int read_float(float *a);
```

Q2 jj.) sort – used to sort data in a file



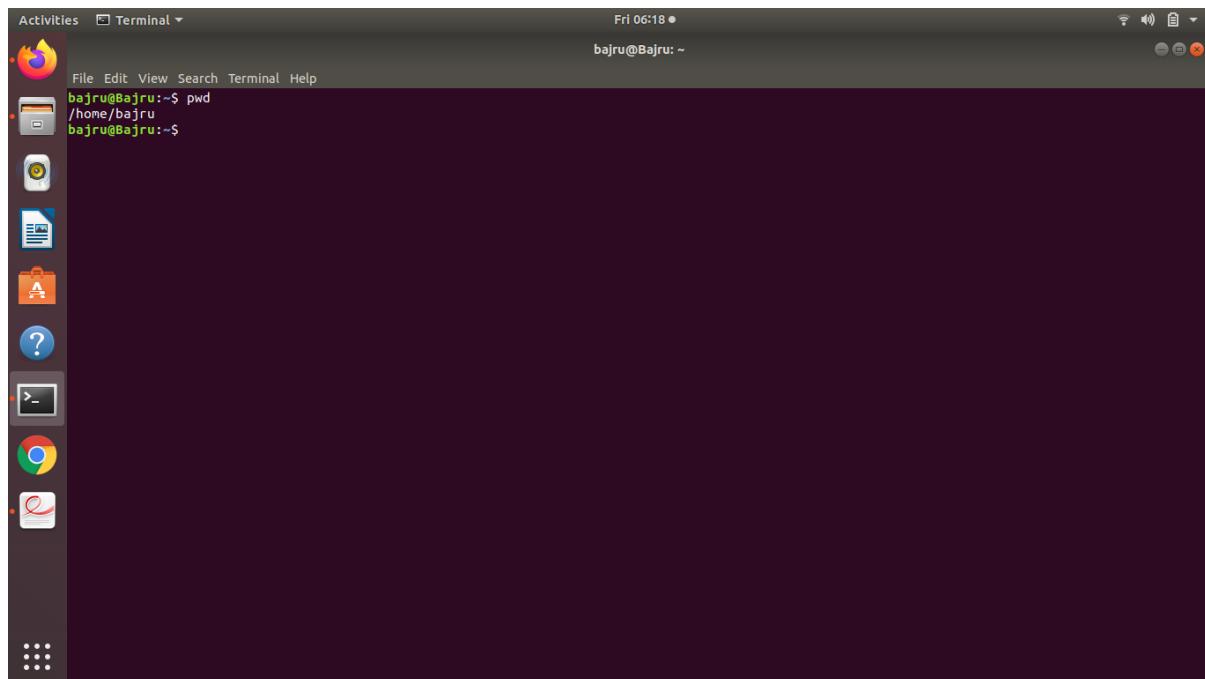
```
Fri 06:16 ● bajru@Bajru: ~
Activities Terminal Fri 06:16 ● bajru@Bajru: ~
File Edit View Search Terminal Help
bajru@Bajru:~$ sort input.txt
165417 Cathryn Danner 72000
273225 Matt Meeden 69000
471163 Robert Dufour 91000
485913 Dylan Steinberg 84000
499959 Mike Griffin 72000
547935 Daniel McNamee 71000
553997 Peter Olsen 82000
633974 Martine Marshall 99000
702234 Jean Jones 94000
784372 Dana Parrish 87000
786785 Ann Coddington 82000
849387 Melissa Dufour 114000
935460 Heather James 98000
970016 Russ Voroblev 109000
bajru@Bajru:~$
```

Q2 kk.) export – used to list the environment or program variables or functions

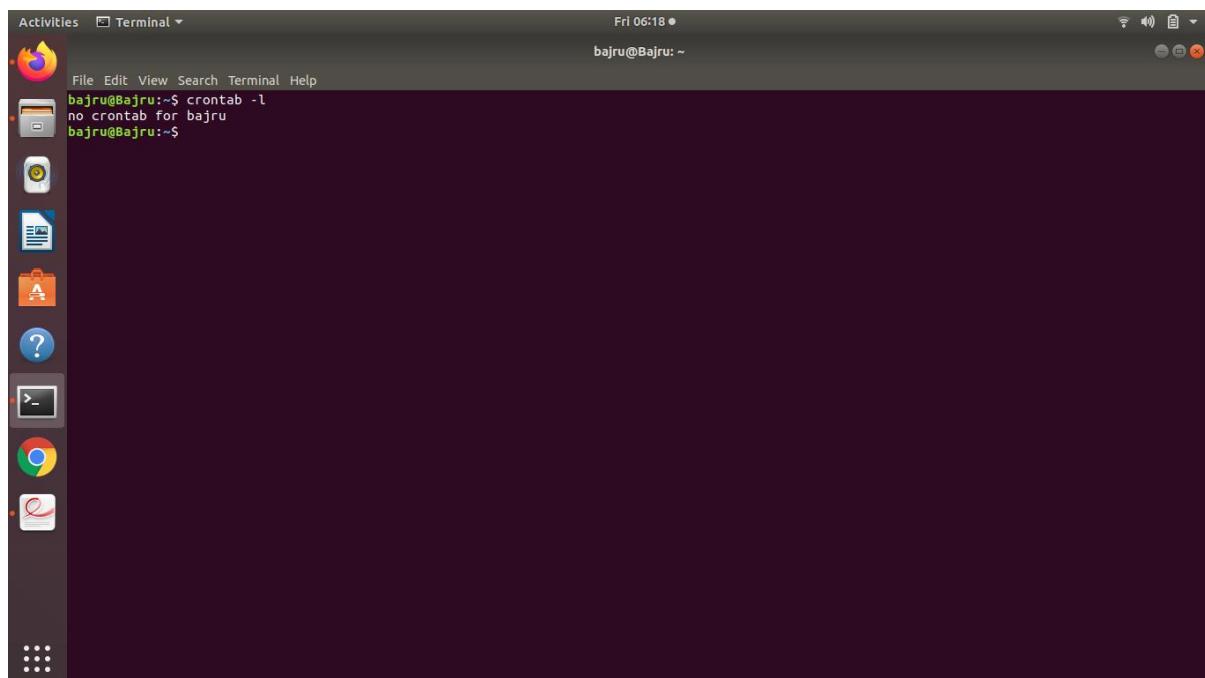


```
Fri 06:17 ● bajru@Bajru: ~
Activities Terminal Fri 06:17 ● bajru@Bajru: ~
File Edit View Search Terminal Help
bajru@Bajru:~$ export
declare -x ANDROID_SDK_ROOT="/home/bajru/Android/Sdk/emulator"
declare -x CLUTTER_IM_MODULE="xim"
declare -x COLORTERM="truecolor"
declare -x DBUS_SESSION_BUS_ADDRESS="unix:path=/run/user/1000/bus"
declare -x DESKTOP_SESSION="ubuntu-wayland"
declare -x DISPLAY=:0"
declare -x GDMSESSION="ubuntu-wayland"
declare -x GJS_DEBUG_OUTPUT="stderr"
declare -x GJS_DEBUG_TOPICS="JS ERROR;JS LOG"
declare -x GNOME_DESKTOP_SESSION_ID="this-is-deprecated"
declare -x GNOME_SHELL_SESSION_MODE="ubuntu"
declare -x GNOME_TERMINAL_SCREEN="/org/gnome/Terminal/screen/18c6481f_4bb7_4a5f_9786_0d189466b203"
declare -x GNOME_TERMINAL_SERVICE=:1.90
declare -x HOME="/home/bajru"
declare -x IM_CONFIG_PHASE="2"
declare -x JAVA_HOME="/home/bajru/Desktop/android-studio/jre"
declare -x LANG="en_IN"
declare -x LANGUAGE=en_IN"
declare -x LESSCLOSE="/usr/bin/lesspipe %s %s"
declare -x LESSOPEN="| /usr/bin/lesspipe %s"
declare -x LOGNAME="bajru"
declare -x 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=3
0;41: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:*.lz4=01;31:*.lzh=01;31:*.lzma=01;31:*.tlz=01;31:*.txz=01;31:*.tzo=01;31:*.t7z=01;31:*.zip=01;31:*.z=01;31:*.Z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lz=01;31:*.lzo=01;31:*.xz=01;31:*.zst=01;31:*.bz2=01;31:*.bz=01;31:*.tbz=01;31:*.tb2=01;31:*.tz=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:*.war=01;31:*.ear=01;31:*.sar=01;31:*.raf=01;31:*.aiz=01;31:*.zoo=01;31:*.cpio=01;31:*.rz=01;31:*.cab=01;31:*.wtm=01;31:*.swm=01;31:*.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:*.ogm=01;35:*.mp4=01;35:*.m4v=01;35:*.mp4v=01;35:*.vob=01;35:*.qt=01;35:*.nuv=01;35:*.wmv=01;35:*.cgm=01;35:*.emf=01;35:*.ogg=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:*
declare -x MANPATH="/home/bajru/.nvm/versions/node/v6.16.0/share/man:/usr/local/man:/usr/local/share/man:/usr/share/man"
declare -x NVM_BIN="/home/bajru/.nvm/versions/node/v6.16.0/bin"
declare -x NVM_CD_FLAGS=""
declare -x NVM_DIR="/home/bajru/.nvm"
declare -x NVM_ZIP="https://nodejs.org/dist/v6.16.0/node-v6.16.0-linux-x64.tar.gz"
```

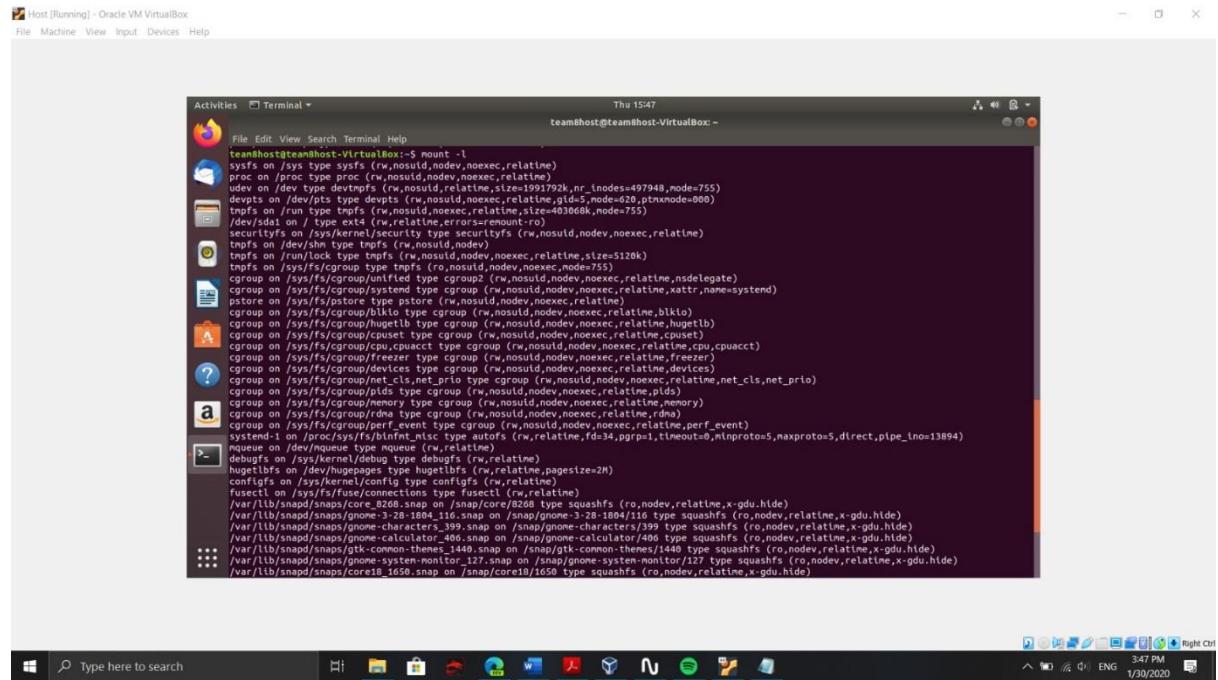
Q2 II.) pwd – used to print the present working directory



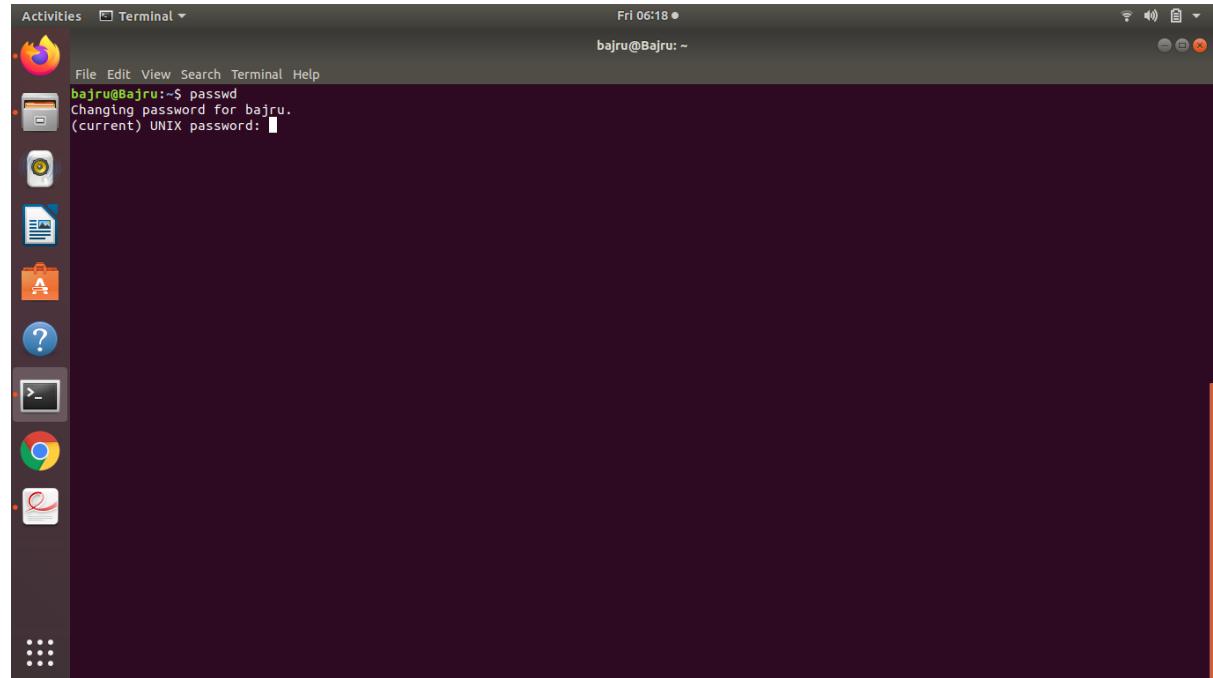
Q2 mm.) crontab – used to list and show the jobs scheduled



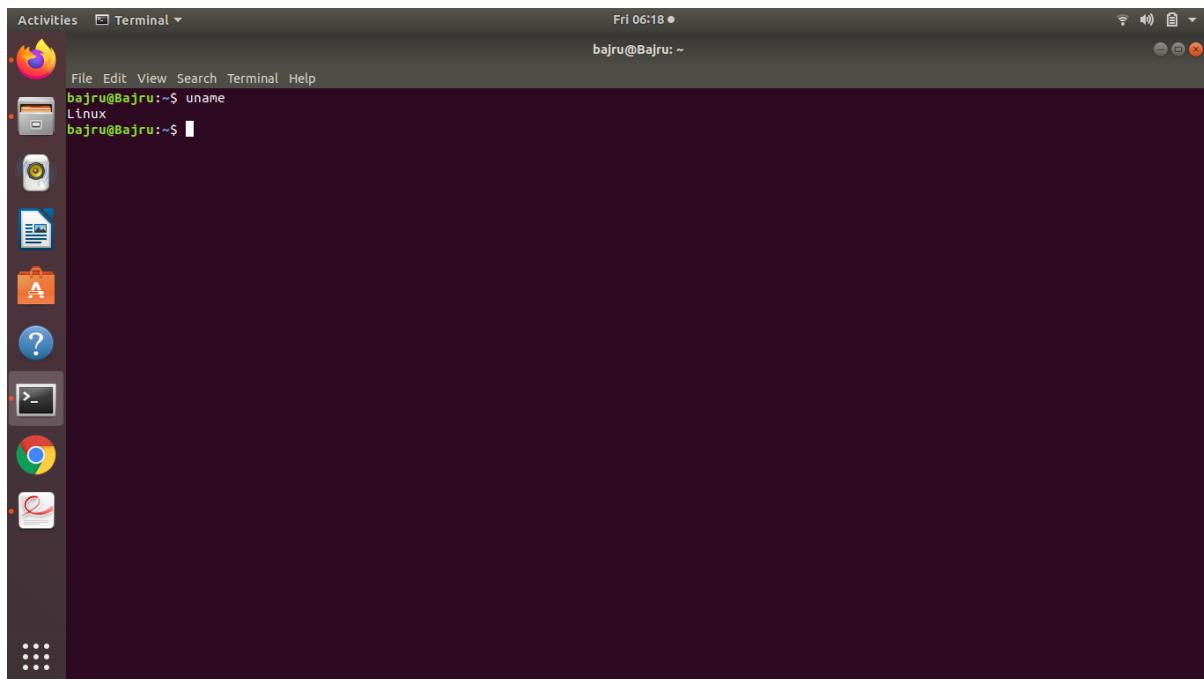
Q2 nn.) mount – used to mount a file system or get the current information about it



Q2 oo.) passwd – used to change the password



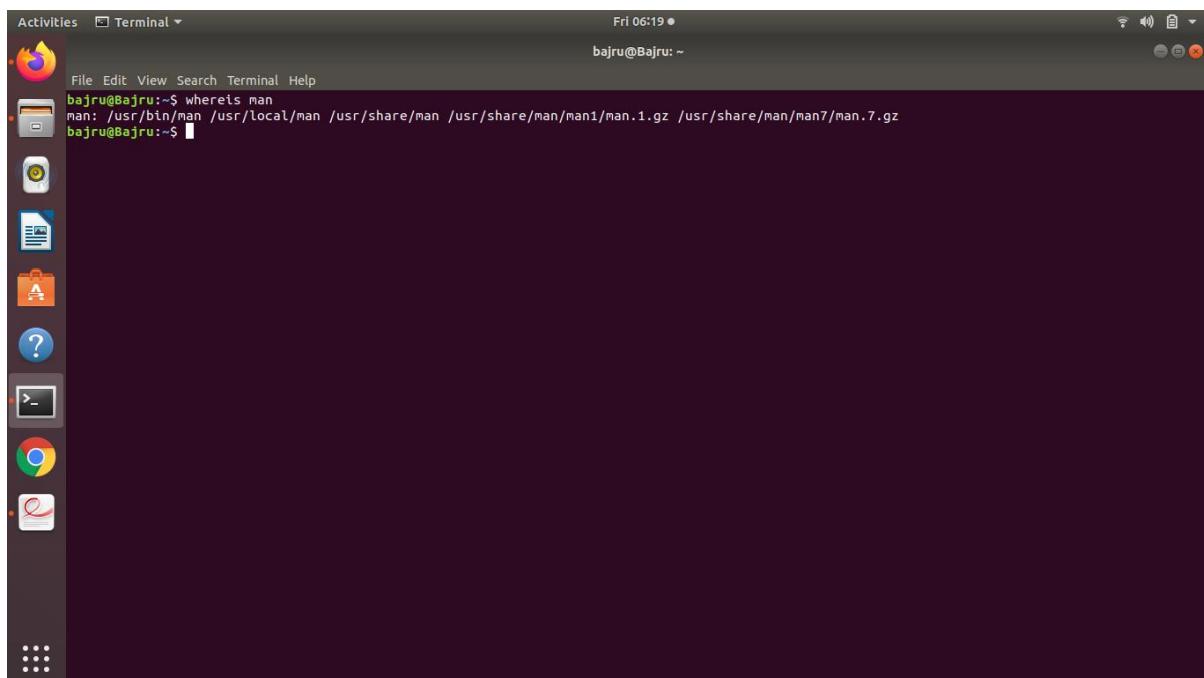
Q2 pp.) uname – Used to get the information of the current machine



A screenshot of an Ubuntu desktop environment. On the left is a vertical dock with icons for various applications like Dash, Home, Dash to Dock, and the Dash search bar. The main area shows a terminal window titled "Terminal". The terminal has a dark background and displays the following text:

```
Fri 06:18 ●  
bajru@Bajru: ~  
File Edit View Search Terminal Help  
bajru@Bajru:~$ uname  
Linux  
bajru@Bajru:~$
```

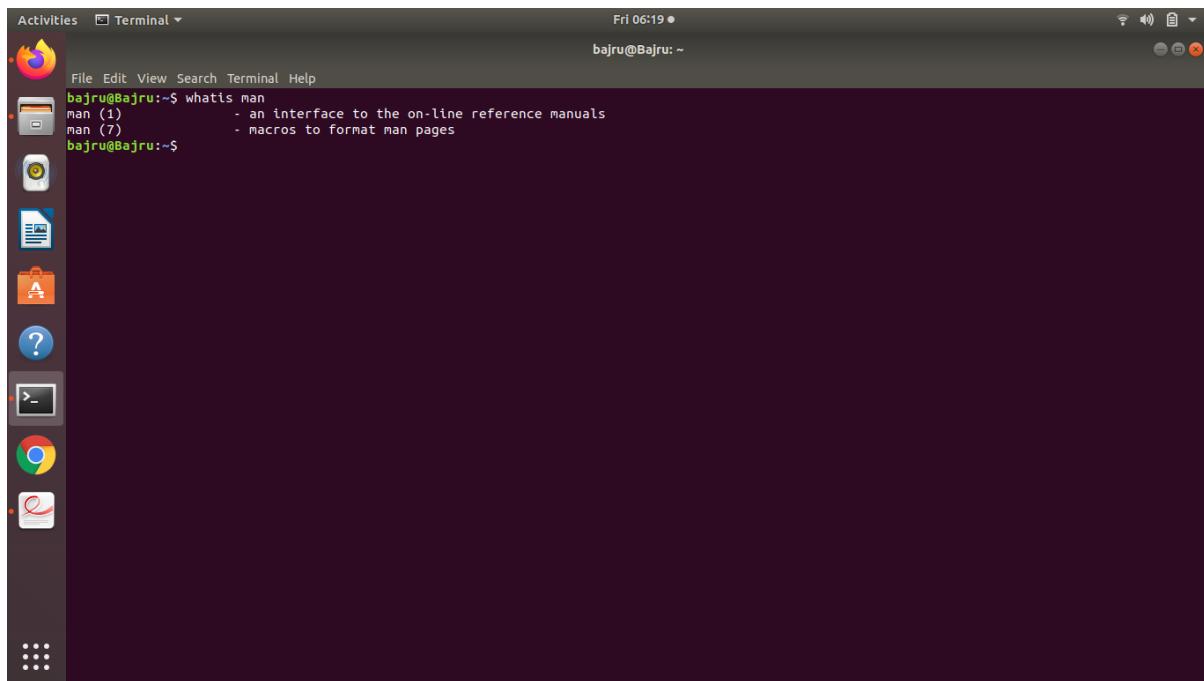
Q2 qq.) whereis – used to find the binary libraries of the command



A screenshot of an Ubuntu desktop environment, identical to the one above, showing a terminal window titled "Terminal". The terminal displays the following text:

```
Fri 06:19 ●  
bajru@Bajru: ~  
File Edit View Search Terminal Help  
bajru@Bajru:~$ whereis man  
man: /usr/bin/man /usr/local/man /usr/share/man /usr/share/man/man1/man.1.gz /usr/share/man/man7/man.7.gz  
bajru@Bajru:~$
```

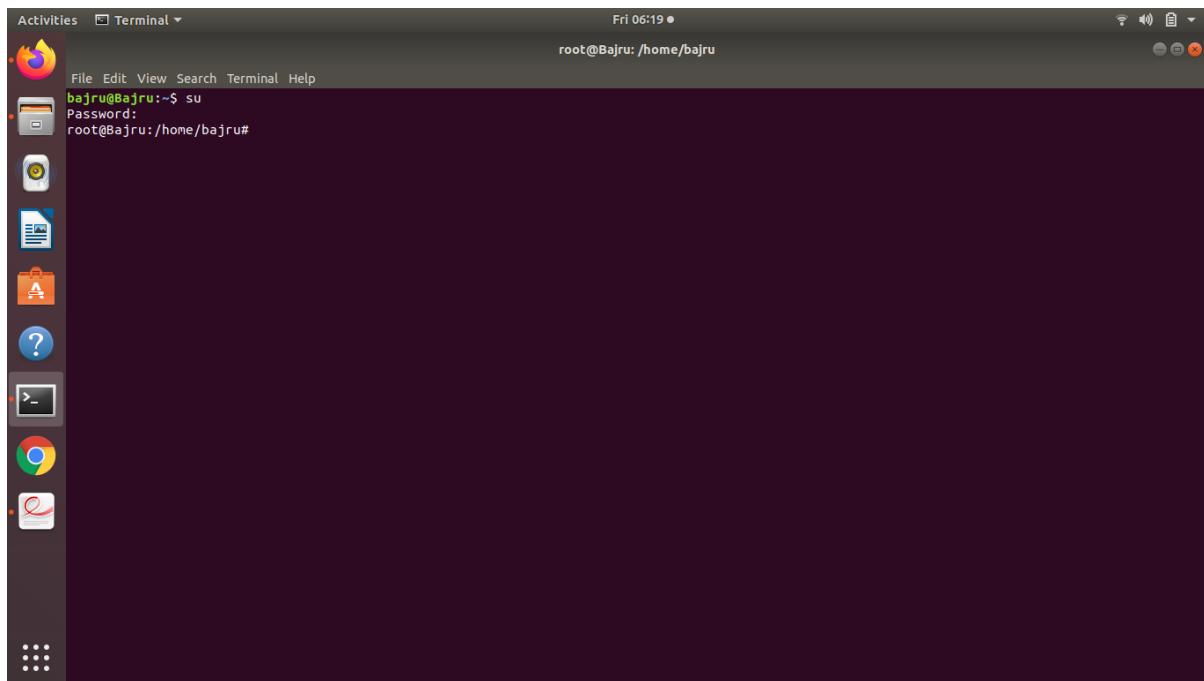
Q2 rr.) whatis – It provides brief description of commands



A screenshot of an Ubuntu desktop environment. On the left is a vertical dock with icons for various applications like Dash, Home, File Explorer, and others. In the center is a terminal window titled "Terminal". The terminal shows the command "whatis man" being run, and the output describes "man" as an interface to online reference manuals. The system tray at the top right shows the date and time as "Fri 06:19" and the user as "bajru@Bajru: ~".

```
bajru@Bajru:~$ whatis man
man (1)           - an interface to the on-line reference manuals
man (7)           - macros to format man pages
bajru@Bajru:~$
```

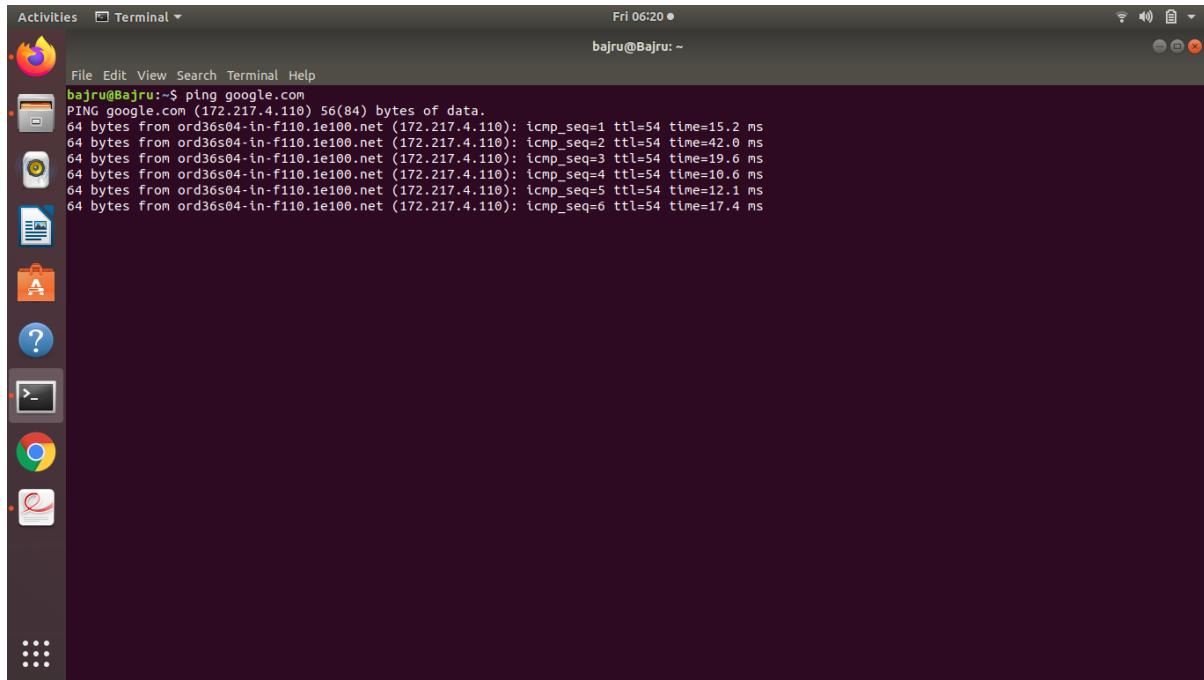
Q2 ss.) su – Used by a user to execute commands as other user



A screenshot of an Ubuntu desktop environment, similar to the previous one. The terminal window shows the command "su" being run, followed by a password prompt. The terminal title bar indicates the user has switched to root, showing "root@Bajru: /home/bajru". The system tray at the top right shows the date and time as "Fri 06:19" and the user as "root@Bajru: /home/bajru#".

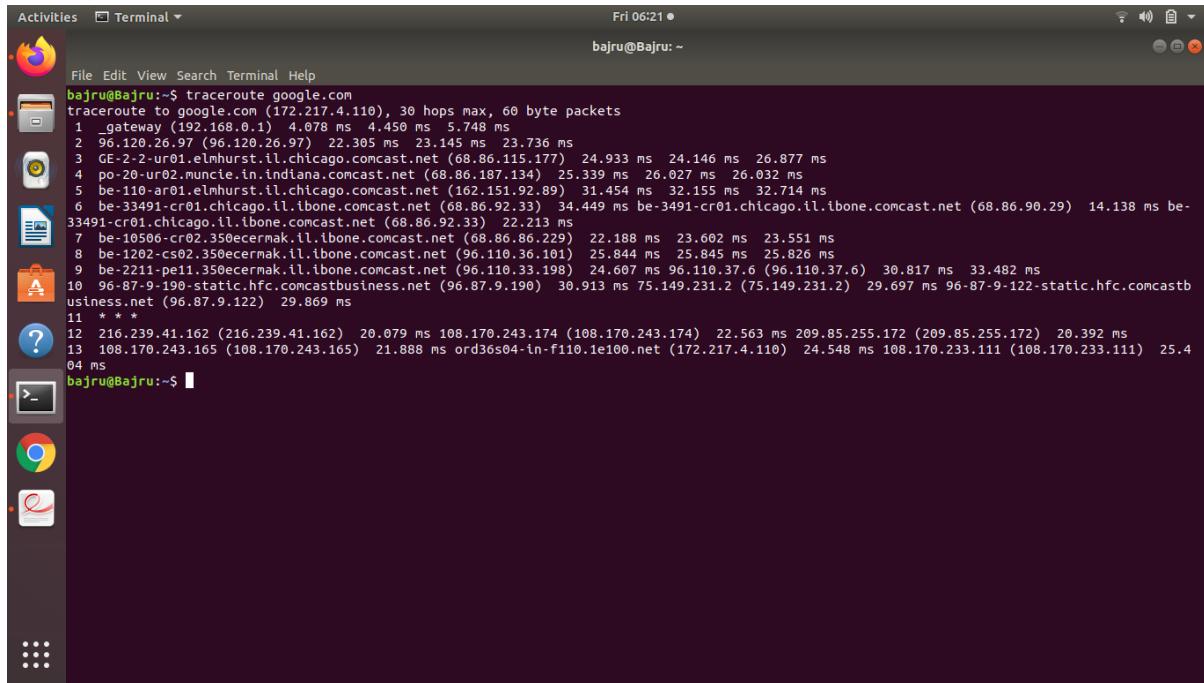
```
bajru@Bajru:~$ su
Password:
root@Bajru:/home/bajru#
```

Q2 tt.) ping – It is used to test the connection between the local system and a server



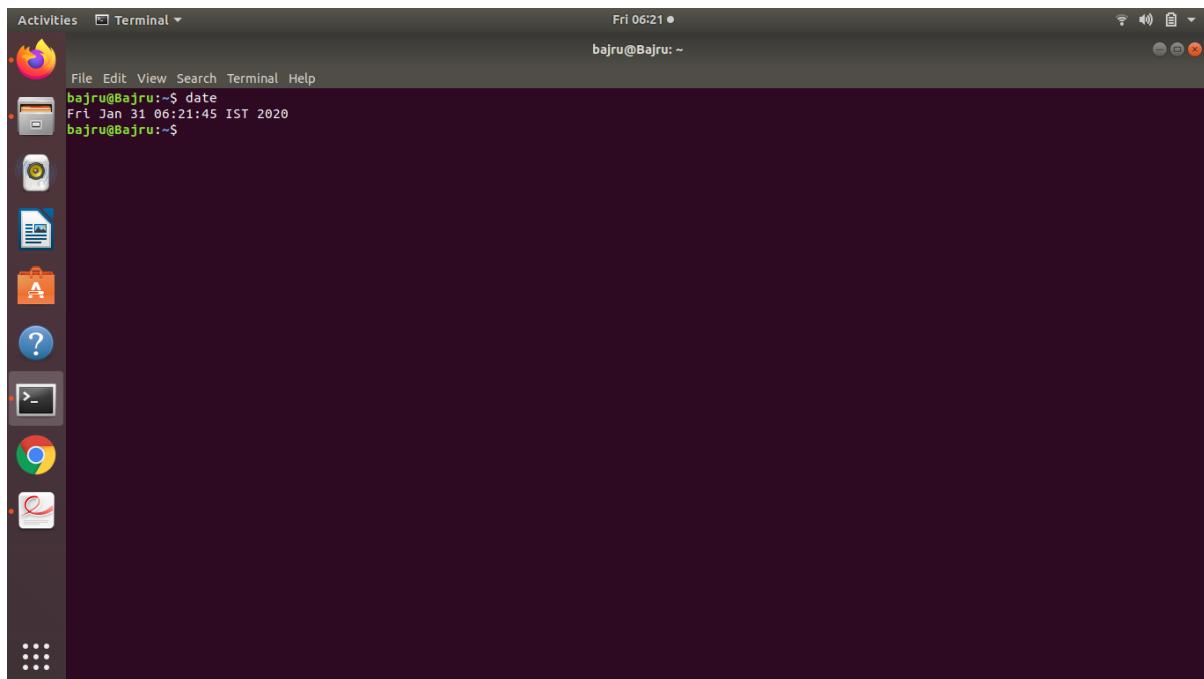
```
Activities Terminal Fri 06:20 ● bajru@Bajru: ~
File Edit View Search Terminal Help
bajru@Bajru:~$ ping google.com
PING google.com (172.217.4.110) 56(84) bytes of data.
64 bytes from ord36s04-in-f110.ie100.net (172.217.4.110): icmp_seq=1 ttl=54 time=15.2 ms
64 bytes from ord36s04-in-f110.ie100.net (172.217.4.110): icmp_seq=2 ttl=54 time=42.0 ms
64 bytes from ord36s04-in-f110.ie100.net (172.217.4.110): icmp_seq=3 ttl=54 time=19.6 ms
64 bytes from ord36s04-in-f110.ie100.net (172.217.4.110): icmp_seq=4 ttl=54 time=10.6 ms
64 bytes from ord36s04-in-f110.ie100.net (172.217.4.110): icmp_seq=5 ttl=54 time=12.1 ms
64 bytes from ord36s04-in-f110.ie100.net (172.217.4.110): icmp_seq=6 ttl=54 time=17.4 ms
```

Q2 uu.) traceroute – It shows how a data is transmitted from a local machine to a server

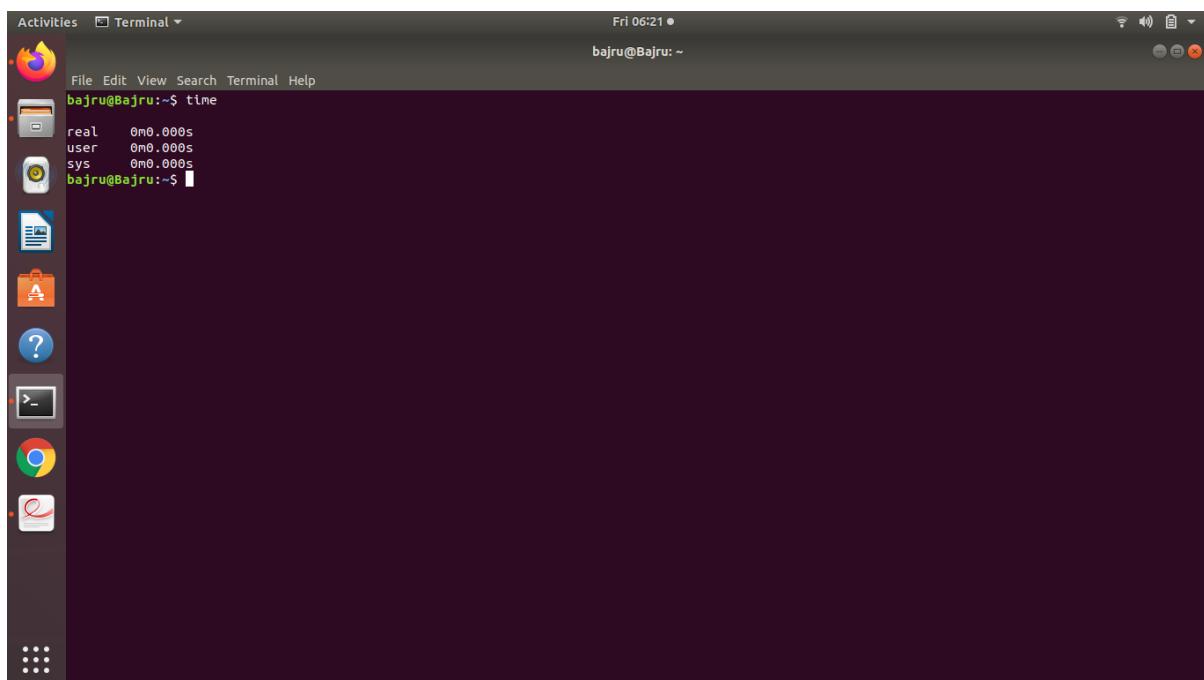


```
Activities Terminal Fri 06:21 ● bajru@Bajru: ~
File Edit View Search Terminal Help
bajru@Bajru:~$ traceroute google.com
traceroute to google.com (172.217.4.110), 30 hops max, 60 byte packets
 1 _gateway (192.168.0.1)  4.078 ms  4.450 ms  5.748 ms
 2 96.120.26.97 (96.120.26.97)  22.305 ms  23.145 ms  23.736 ms
 3 GE-2-2-ur01.elmhurst.il.chicago.comcast.net (68.86.115.177)  24.933 ms  24.146 ms  26.877 ms
 4 po-29-ur02.muncie.in.indiana.comcast.net (68.86.187.134)  25.339 ms  26.027 ms  26.032 ms
 5 be-110-ar01.elmhurst.il.chicago.comcast.net (162.151.92.89)  31.454 ms  32.195 ms  32.714 ms
 6 be-33491-cr01.chicago.ll.libone.comcast.net (68.86.92.33)  34.449 ms be-3491-cr01.chicago.ll.libone.comcast.net (68.86.90.29)  14.138 ms be-
 33491-cr01.chicago.ll.libone.comcast.net (68.86.92.33)  22.213 ms
 7 be-10506-cr02.350ecermak.ll.libone.comcast.net (68.86.86.229)  22.188 ms  23.602 ms  23.551 ms
 8 be-1202-cs02.350ecermak.ll.libone.comcast.net (96.110.36.101)  25.844 ms  25.845 ms  25.826 ms
 9 be-2211-pe11.350ecermak.ll.libone.comcast.net (96.110.33.198)  24.607 ms 96.110.37.6 (96.110.37.6)  30.817 ms  33.482 ms
10 96-87-9-190-static.hfc.comcastbusiness.net (96.87.9.190)  30.913 ms 75.149.231.2 (75.149.231.2)  29.697 ms 96-87-9-122-static.hfc.comcastb
usiness.net (96.87.9.122)  29.809 ms
11 * *
12 216.239.41.162 (216.239.41.162)  20.079 ms 108.170.243.174 (108.170.243.174)  22.563 ms 209.85.255.172 (209.85.255.172)  20.392 ms
13 108.170.243.165 (108.170.243.165)  21.888 ms ord36s04-in-f110.ie100.net (172.217.4.110)  24.548 ms 108.170.233.111 (108.170.233.111)  25.4
04 ms
bajru@Bajru:~$
```

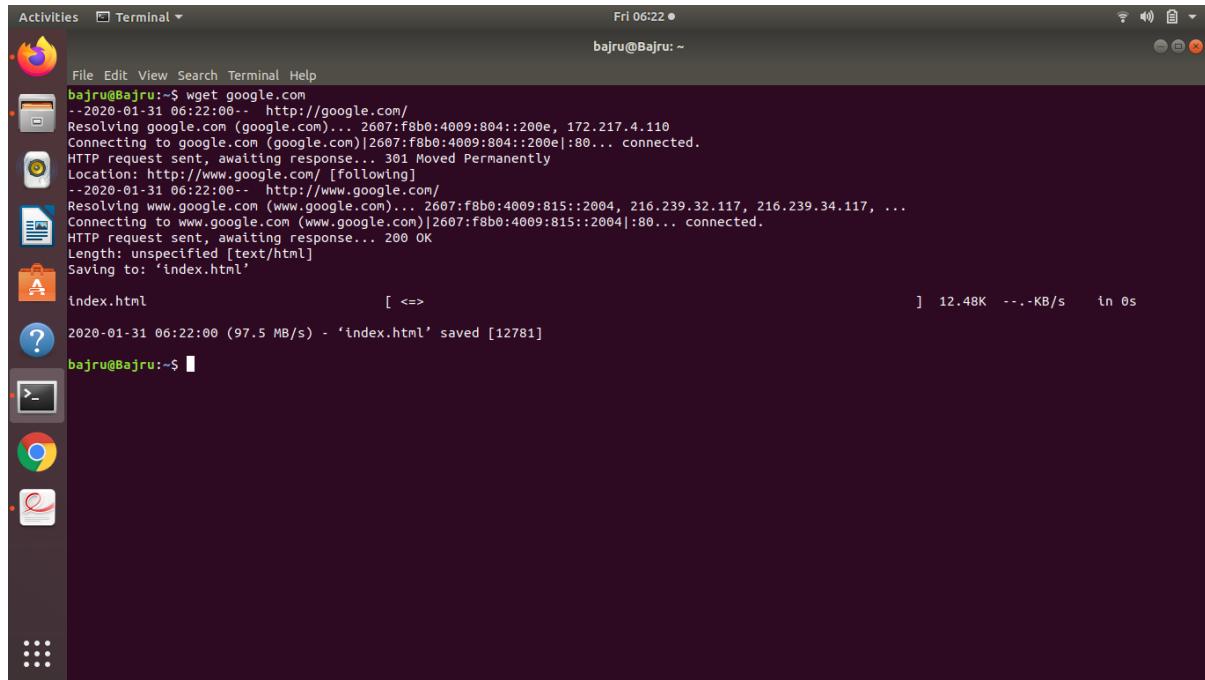
Q2 vv.) date – used to show the current date



Q2 ww.) – time – Used to get the running time of a program



Q2 xx.) wget – It is used to download the files from the server



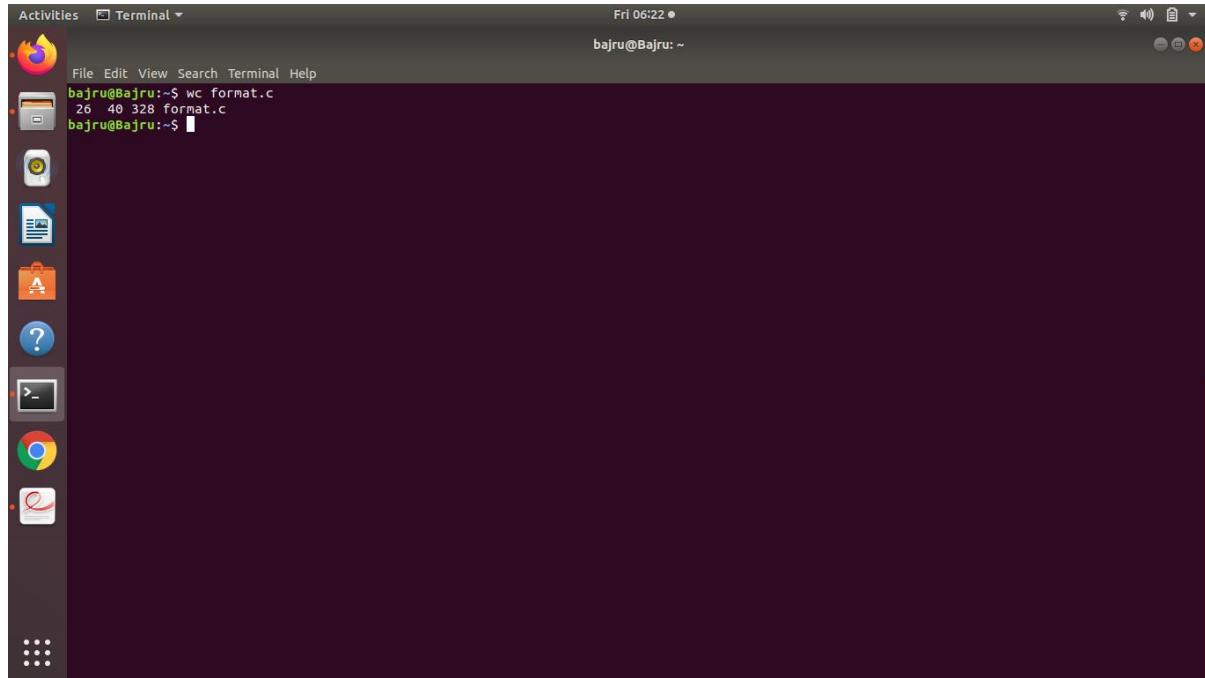
A screenshot of an Ubuntu desktop environment. A terminal window is open in the center, showing the command `wget google.com` being run. The output of the command shows the download of the Google homepage as `index.html`. The terminal window has a dark background and light-colored text. The title bar says "Activities Terminal". The status bar at the top right shows the date and time as "Fri 06:22". The desktop background is a dark blue gradient.

```
bajru@Bajru:~$ wget google.com
--2020-01-31 06:22:00-- http://google.com/
Resolving google.com (google.com)... 2607:f8b0:4009:804::200e, 172.217.4.110
Connecting to google.com (google.com)|2607:f8b0:4009:804::200e|:80... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: http://www.google.com/ [following]
--2020-01-31 06:22:00-- http://www.google.com/
Resolving www.google.com (www.google.com)|2607:f8b0:4009:815::2004, 216.239.32.117, 216.239.34.117, ...
Connecting to www.google.com (www.google.com)|2607:f8b0:4009:815::2004|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: unspecified [text/html]
Saving to: 'index.html'

index.html                                              [ =>          ] 12.48K  ---KB/s   in 0s

2020-01-31 06:22:00 (97.5 MB/s) - 'index.html' saved [12781]
bajru@Bajru:~$
```

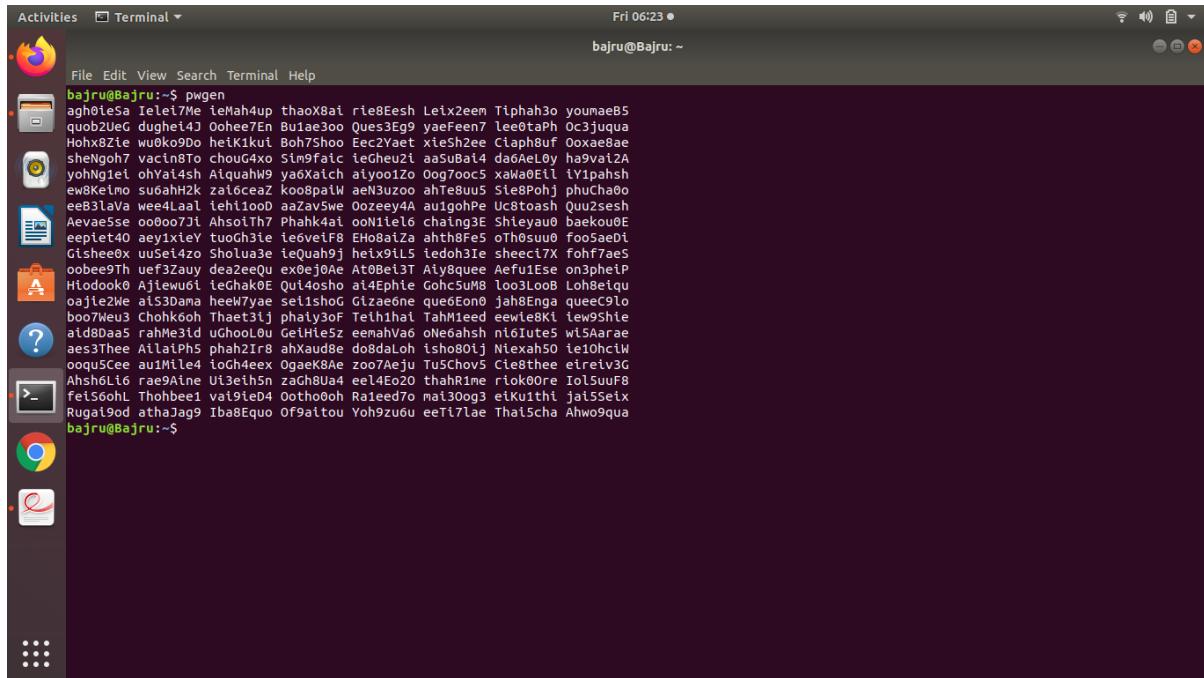
Q2 yy.) wc – Used to get regarding word, newline, space etc count in a file



A screenshot of an Ubuntu desktop environment. A terminal window is open in the center, showing the command `wc format.c` being run. The output of the command shows the word count, character count, and byte count for the file `format.c`. The terminal window has a dark background and light-colored text. The title bar says "Activities Terminal". The status bar at the top right shows the date and time as "Fri 06:22". The desktop background is a dark blue gradient.

```
bajru@Bajru:~$ wc format.c
26 40 328 format.c
bajru@Bajru:~$
```

Q2 zz.) pwgen – used to generate a random password



A screenshot of a Linux desktop environment. The terminal window shows the command 'pwgen' being run, generating a long string of random characters. The desktop interface includes a dock with icons for various applications like a browser, file manager, and terminal.

```
bajru@Bajru:~$ pwgen  
agh0leSa Ielei7Me ieMah4up thaoX8ai rie8Eesh Leix2eem Tiphah3o youmaeBS  
quob2UeG dughel4j Oohee7En Buiae3oo Ques3Eg9 yaeFeen7 Lee0taPh Oc3juqua  
Hohx8Zle wu0ko9do heiKikut Boh7Shoo Eec2Yaet xieshZee CiaphaBuf Oxaebae  
sheNgoh7 vacin8To chou4xo Sim9faic ieGheu2l aasubai4 da6el0y ha9val2A  
yohNg1ei ohYai4sh AiquahW9 ya6xaich aiyoo1Zo Oog70oc5 xawa0fil iY1pahsh  
ew8Ketmo suuahH2k za16ceaz koo8palW aem3uzoo ahTe8u5 Ste8Pohj phuChao  
eeB3laVa weel4ala teliiod aazav5we Oozzeey4A auigohPe Uc8toash Quuzesh  
Aeveae5s oo0oo73i AhsoiTTh Phahk4ai oonNlel6 chaing3E Shleyau0 baekou0E  
eeplet40 aey1xieY tuoGh3le ie6veif8 EH08aiZa ahth8Fe5 Oth0suu0 Foo5aeDi  
Gishee0x uusei4zo Sholu3e iequahp9j heix9L5 iedoh3Ie sheec17X fohf7aeS  
oobee9th uef3zauy dea2eequ ex0ej0Ae At0Be13T Aly8quee Aefu1Ese on3pheip  
Hi0dook0 Ajiewu6i ieGhak0E Qui4osh0 aia4phite GohcSuMB loo3LooB Loh8eiqu  
oajjle2We als53dama heew7ya se11shoC Gizaee6ne que6Eon0 Jah8Enga queeC0lo  
boo7weu3 chonkoh0 Thaet3ij phaly3of ieithihai TahMiedd eeWle8K1 tew5Shie  
atld8daa5 rahMe3Id uGhooL0u GetHle5z eemahV6 oNe6ahsh ni6iute5 wl5arae  
aes3thee AtllaPh5 phah2Ir8 ahxaud8e do8daloh isho80ij Niexah50 le10hc1w  
oouq5Cee au1Mle4 ioChaeex OgaekBAe zootAeju Tu5Chov5 C1e8thee eiRetv3G  
Ahsh6L16 rae9Aimn Ul3eih5n zagh8uA4 ee14Eo20 thahRime riok0ore Iol5uuF8  
feis6ohL Thohbee1 vai9teD4 Ootho0oh Raileed7o mai30og3 eikuithi ja15Seix  
Ruga19od athajag9 Iba8Equo Of9aitou Yoh9zu6u eeTi7lae Thai5cha Awo9qua  
bajru@Bajru:~$
```

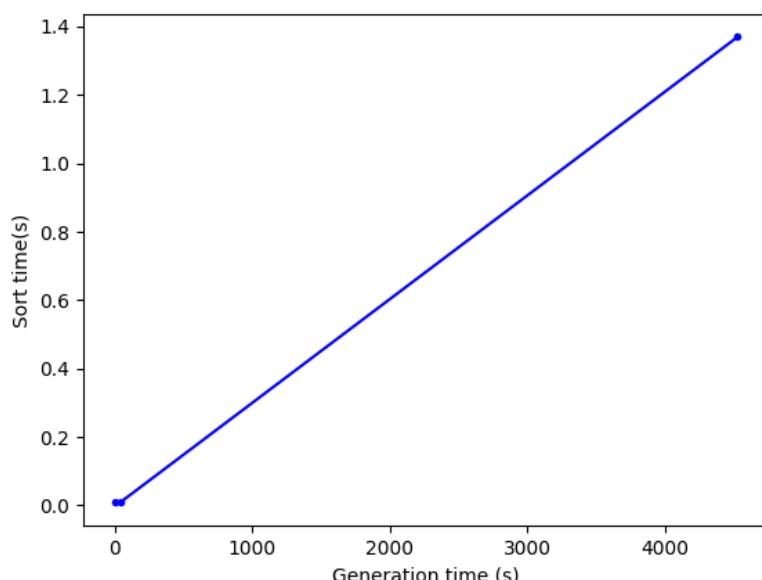
Q3 a.) 2500 records were generated in 10 seconds

Q3 b.) Time taken to sort the number of records is below

1. 100 records – 0.008 seconds
2. 10,000 records – 0.008 seconds
3. 10,00,000 records – 1.37 seconds

Q3 c.) Time taken to generate the number of records is below

1. 100 records – 0.38 sec
2. 10,000 records – 41 seconds
3. 10,00,000 records – 75 minutes and 28 seconds



Q4 a.) The performance of the VMs depends on the number of processors set. This is because the no. of processors can be set to any number depending on the software but the actual hardware processor is limited which will be shared by all the processors in the VM. If we increase it too much than the actual hardware processor, then each program will take too much time as they would have to wait for their turn to run the process while too can also result in poor performance as we won't be able to run programs in parallel.

We should set the number of processors to minimum when the VM is running a single process for a majority of its time such as where the usage is mostly office and internet based applications

We should set the number of processors to maximum when the VM is used as a server or for heavy data driven applications

Q4 b.) Various paravirtualization options are:

1. None – It turns off any paravirtualization interface
2. Legacy – Used for systems which have been created with older versions so that they can run older applications smoothly
3. Minimal – It announces the presence of a virtualised environment and is mandatory for running any Mac OS X guests
4. Hyper-V - It basically allows to run a VM over the top of a VM. It is generally recommended for windows
5. KVM - It is a very powerful yet simple virtualization engine that gives linux kernel native virtualization capabilities.

The KVM would be best suitable to use with Ubuntu or Linux because KVM uses hardware based virtualization which does not require modifying any guest OS's.

Q4 c.) Different type of storage controller are:

1. **IDE** - These controllers expose IDE disks to the virtual machine. The IDE controller is emulated, and it is the only controller that is available for guest VMs running older version of This should be preferred to be used for operating systems
2. **SATA** – This is a modern controller and can be used to support much higher number of devices. It also runs faster than IDE. This should be used for small or medium scaled servers
3. **NVMe** - This is an interface for non-volatile storage media such as SSD. These allow a much faster service than other controllers. It should be used in servers where very fast and low latency transactions are required

Q4 d.) Different type of network adapters are:

1. **NAT (Network Address Translation)** – provides a simple way for virtual machines to use most client applications over almost any type of network connection available to the host. The only requirement is that the network connection must support TCP/IP. It should be used in Web Applications like email, browsing and downloading files etc.
2. **Bridged Adapter** – This is a more advanced where when connected to the host's network cards, it exchanges packets directly without interrupting the host OS network. This requires it to have its own IP address. It is used for network simulations and running servers on guest

3. **Internal Network** – This is used to directly connect to other VM on the same host which connect to the same internal network. This can be used to test new firewalls or upgrades in it
4. **Host-only Network** – It is a form of hybrid between internal and bridged network and can be used for communication between host-VM and VM-VM. It is used to setup isolated virtual networks between host and VM

Q4 e.)

USB 1.1	USB 2.0	USB 3.0
OHCI(Universal Host Controller Interface)	EHCI(Enhanced Host Controller Interface)	XCI(Extensible Host Controller Interface)
Supported by all VM Hardware versions	Supported by only compatible VM Hardware Versions	Supported by Linux guests with Kernel version 2.6.35 or later and for Windows 8 guests.
Maximum bandwidth 12 Mbps	Maximum bandwidth 480 Mbps	Maximum bandwidth 4.8 Gbps
Devices: Keyboard, mouse, printer etc.	Devices: mass storage devices, video adapters, data transfer cables etc.	Devices: large mass storage devices, huge data transfer cables etc.

Q5 a.) A core is a physical core on CPU die. Hardware thread refers to using core as substitute thread. A core can be a thread but a thread cannot be core.

Q5 b.) Different processors are:

1. Intel CPU (x86):
 - a. Name - Intel Xeon Platinum 9282
 - b. Base Clock (GHz) – 2.6
 - c. Boost Clock (GHz) – 3.8
 - d. Cores – 56
 - e. Threads – 112
 - f. Architecture – 14nm
 - g. Price – 25k USD – 50k USD
2. AMD CPU (x86):
 - a. Name - AMD Epyc 7742
 - b. Base Clock (GHz) – 2.25
 - c. Boost Clock (GHz) – 3.4
 - d. Cores – 64
 - e. Threads – 128
 - f. Architecture – 7nm
 - g. Price – 25k USD – 7k USD
3. IBM CPU (Power9):
 - a. Name - IBM Power9 02CY089
 - b. Base Clock (GHz) – 3.5
 - c. Boost Clock (GHz) – 3.8
 - d. Cores – 8
 - e. Threads – 32

f. Architecture – 14nm

g. Price – 5k USD

4. ThunderX CPU (ARM):

- a. Name - CaviumThunderX2 9980-2200
- b. Base Clock (GHz) – 2.2
- c. Boost Clock (GHz) – 2.5
- d. Cores – 32
- e. Threads – 128
- f. Architecture – 16nm
- g. Price – 1795 USD

5. NVIDIA GPU:

- a. Name - Nvidia Titan RTX(GPU)
- b. Base Clock (GHz) – 1.35
- c. Boost Clock (GHz) – 1.75
- d. CUDA Cores – 4608
- e. Tensor Cores – 576
- f. RT Cores - 72
- g. Threads – 112
- h. Architecture – 12nm
- i. Price – 2499 USD

Q5 c.) The reason we don't have 1THz processor is that when we increase the number of transistors on a IC Chip, it results in higher generation of heat. The cooling option we have right now are very limited and thus due to high temperature processor will melt. We have more economical options where we can get better performance using multi-processor where the heat increase is only linear.

Q5 d.) Moore's law state that the number of transistors on a chip will double every year. This law has been holding on for quite a long time even if it has slowed somewhat recently. But we have started to hit the technological limitation of the current engineering. Chips as small as 3nm are in development and we are very close to hitting the limit of physical dimension limitation. Due to this there's a possibility that in the next 5 years or so, Moore's law will die unless there's a new technological advancement which allows us to make even much smaller transistors.

Q6 a.) Threading is useful on a single core processor as it facilitates in running two process at the same time. The core can finish a part of one process and work on the other while the first process is fetching data from memory. It basically allows us to run multiple applications at the same time

Q6 b) No, more threads don't always mean more performance. There is an overhead cost that comes with threading and when the number of threads are very large or each thread is very small, the overhead becomes more than the saving done by threading.

Q6 c) Theoretically super-linear speedups are not possible but they have been able to achieve them in real life. This is done primarily by utilising other benefits of parallel processing. For ex - With multiple processor, you can have their own cache memory and end up saving a lot of time by reducing the number of IO operations

Q6 d) Locks are needed in a multi-threaded program to make sure that correct copy of data is accessed every time. For ex – A variable is accessed by two programs to keep count of something. Now in case there is no lock and the second program reads it before first can update it, it will result in incorrect information which should be avoided.

Q6 e) Yes, you should limit the number of threads on a server process. Each thread comes with an memory overhead of its own and if it becomes too high, server might not enough memory to work properly.