CSD204 - OS - Lab01

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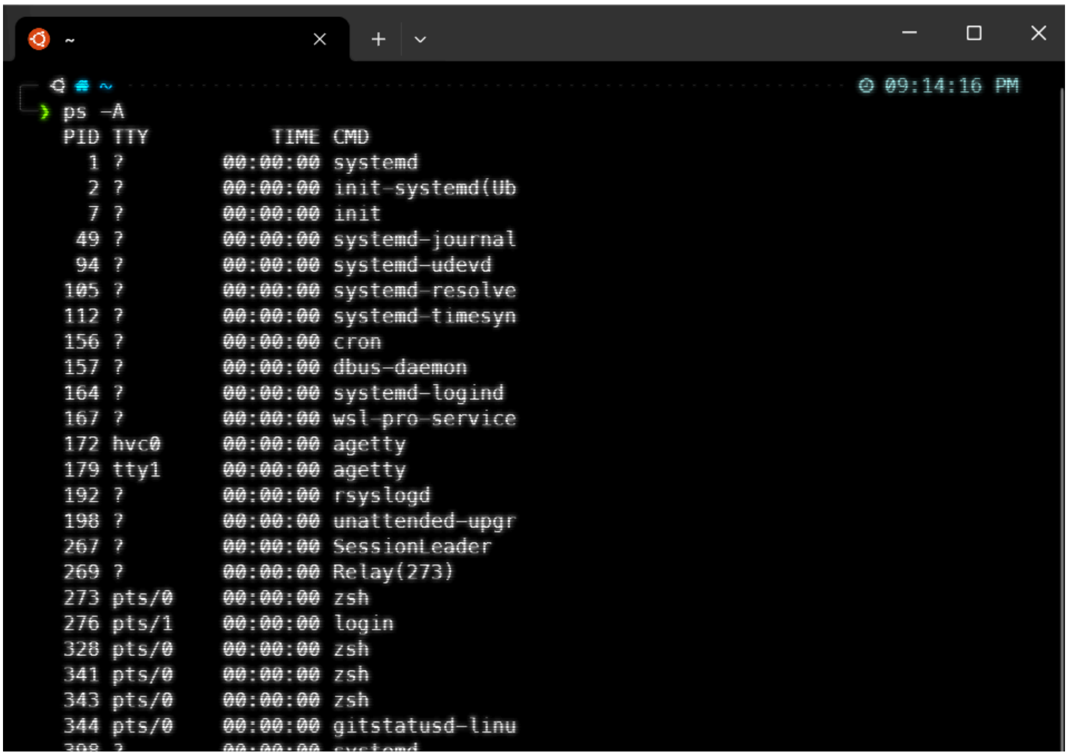
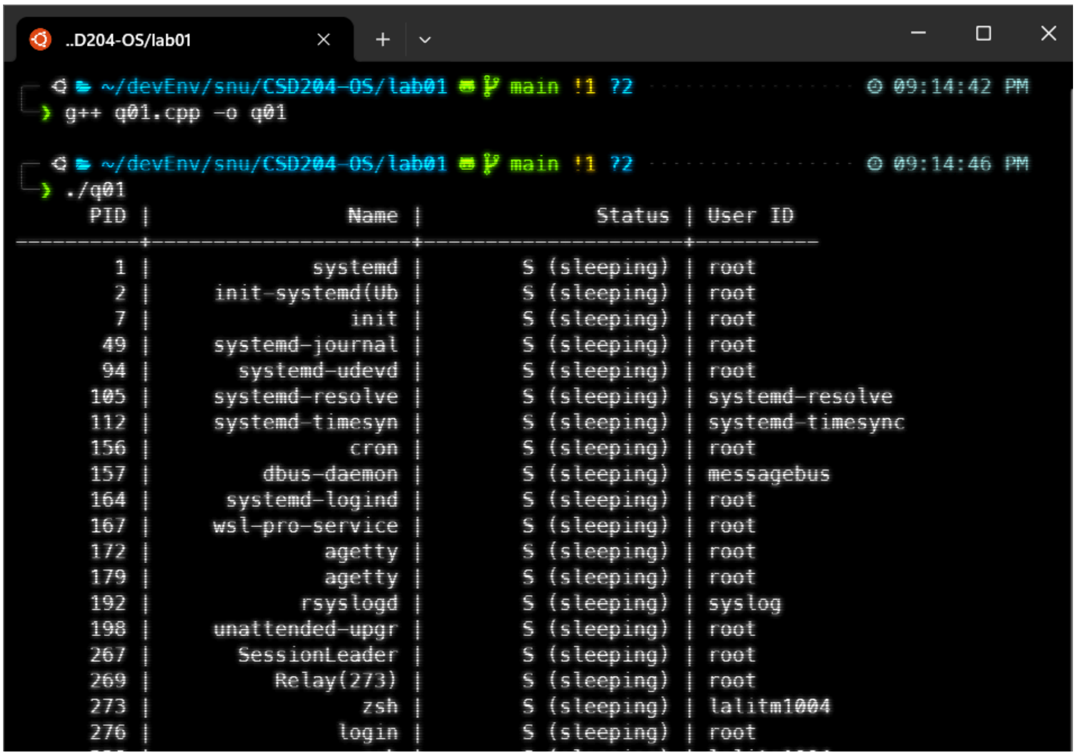
Question 1



```
~
~                                                   09:14:16 PM
> ps -A
  PID TTY          TIME CMD
    1 ?        00:00:00 systemd
    2 ?        00:00:00 init-systemd(Ub
    7 ?        00:00:00 init
   49 ?        00:00:00 systemd-journal
   94 ?        00:00:00 systemd-udevd
  105 ?        00:00:00 systemd-resolve
  112 ?        00:00:00 systemd-timesyn
  156 ?        00:00:00 cron
  157 ?        00:00:00 dbus-daemon
  164 ?        00:00:00 systemd-logind
  167 ?        00:00:00 wsl-pro-service
  172 hvc0     00:00:00 agetty
  179 tty1     00:00:00 agetty
  192 ?        00:00:00 rsyslogd
  198 ?        00:00:00 unattended-upgr
  267 ?        00:00:00 SessionLeader
  269 ?        00:00:00 Relay(273)
  273 pts/0    00:00:00 zsh
  276 pts/1    00:00:00 login
  328 pts/0    00:00:00 zsh
  341 pts/0    00:00:00 zsh
  343 pts/0    00:00:00 zsh
  344 pts/0    00:00:00 gitstatusd-linu
```



```
..D204-OS/lab01
~/devEnv/snu/CSD204-OS/lab01  main !1 ?2            09:14:42 PM
> g++ q01.cpp -o q01

~/devEnv/snu/CSD204-OS/lab01  main !1 ?2            09:14:46 PM
> ./q01
     PID |                 Name |               Status | User ID
---------+----------------------+----------------------+-----------
       1 |              systemd |         S (sleeping) | root
       2 |      init-systemd(Ub |         S (sleeping) | root
       7 |                 init |         S (sleeping) | root
      49 |      systemd-journal |         S (sleeping) | root
      94 |        systemd-udevd |         S (sleeping) | root
     105 |      systemd-resolve |         S (sleeping) | systemd-resolve
     112 |      systemd-timesyn |         S (sleeping) | systemd-timesync
     156 |                 cron |         S (sleeping) | root
     157 |          dbus-daemon |         S (sleeping) | messagebus
     164 |       systemd-logind |         S (sleeping) | root
     167 |      wsl-pro-service |         S (sleeping) | root
     172 |               agetty |         S (sleeping) | root
     179 |               agetty |         S (sleeping) | root
     192 |             rsyslogd |         S (sleeping) | syslog
     198 |      unattended-upgr |         S (sleeping) | root
     267 |        SessionLeader |         S (sleeping) | root
     269 |           Relay(273) |         S (sleeping) | root
     273 |                  zsh |         S (sleeping) | lalitm1004
     276 |                login |         S (sleeping) | root
```

Comparison of `q01.cpp` against `ps -A`:

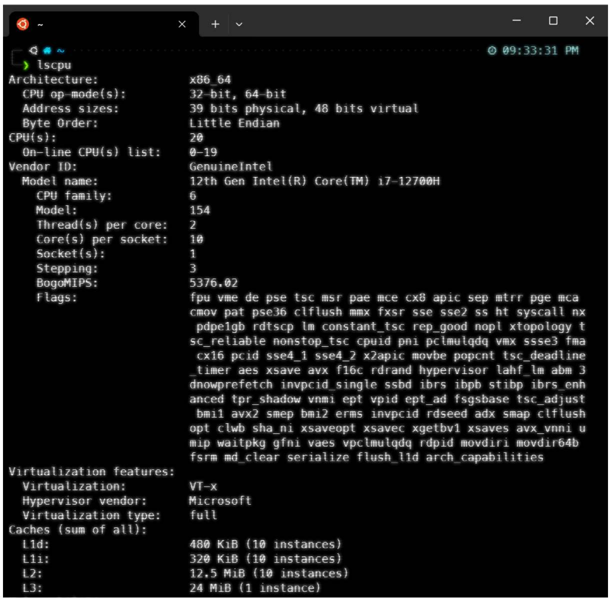
Similarities	Differecnes
• Both iterate over all running process and display them • Both map the uid to the username using `/etc/passwd`	• The program only extracts a subset of the information that ps -A does. • `ps -A` provides additional information such as cpu time and terminal name

Question 2

```
  ~/devEnv/snu/CSD204-OS/lab01  main !1 ?2                    09:27:45 PM
 > ./q02
        Kernel Version
------------------------------
Linux version 5.15.167.4-microsoft-standard-WSL2 (root@f9c826d3017f) (gcc (GCC) 11.
2.0, GNU ld (GNU Binutils) 2.37) #1 SMP Tue Nov 5 00:21:55 UTC 2024

        Memory Information
------------------------------
MemTotal:        7940460 kB
MemFree:         7270388 kB
MemAvailable:    7247664 kB

        CPU Information
------------------------------
      Processor|           Cores| Model Name
---------------+----------------+----------------------------------------
              0 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              1 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              2 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              3 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              4 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              5 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              6 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              7 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              8 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
              9 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             10 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             11 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             12 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             13 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             14 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             15 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             16 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             17 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             18 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
             19 |             10 | 12th Gen Intel(R) Core(TM) i7-12700H
```

The program parses through `/proc/meminfo`, `/proc/version`, and `/proc/cpuinfo` to gather information about the system. It then formats them into a table for easy visualization.

Question 3



Part A

Processor : The term processor in `more /proc/cpuinfo` refers to the index of the processor who's information is being displayed in the current block. This is a zero indexed value that goes up to 19 on my system. Which would mean that my system has 20 processors. This is verified by `lscpu`. Note that this number is due to hyperthreading which creates the illusion of double the processors. The number of physical processors on my system is 10.

Cores : A core is an individual processing unit within a processor. A core can work on multiple threads at once via hyperthreading.

Hyperthreading allows a core to run multiple threads, 2 for my system.

Part B

By running

```
$ lscpu | grep -E 'Socket|Core|Thread|'
Model name:                    12th Gen Intel(R) Core(TM) i7-12700H
Thread(s) per core:            2
Core(s) per socket:            10
Socket(s):                     1
```

We can calculate number of physical cores via: numCores * numSockets = $10 * 1 = 10$. We can account for the virtual cores via accounting for hyperthreading. We simply need to multiply the total number of physical cores with numThreads/core resulting in 20 cores total.

Part C

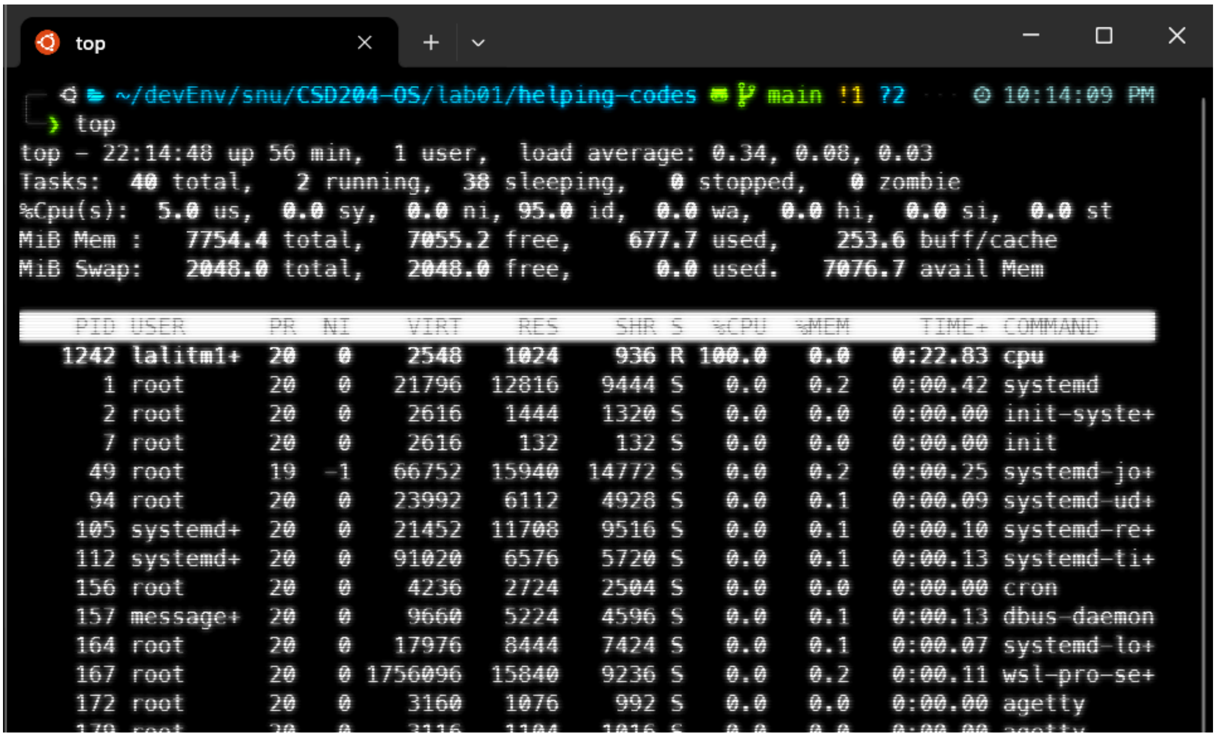
The number of processors is the same as the number of virtual cores on our system. Which is 20.

Part D-H

- cpu MHz : 2688.010
- Architecture: x86_64
- MemTotal: 7940460 kb ~ 7.94046 GB

- MemFree: 7239552 kb ~ 7.23955 GB
- NumForks: 1560
- Context Switches: 292997

Question 4



Part A - C

- The process id of the `./cpu` program is `1242`.
- The process is occupying a 100% of CPU and 0% of MEM.
- The current state of the process is `R - Running`.

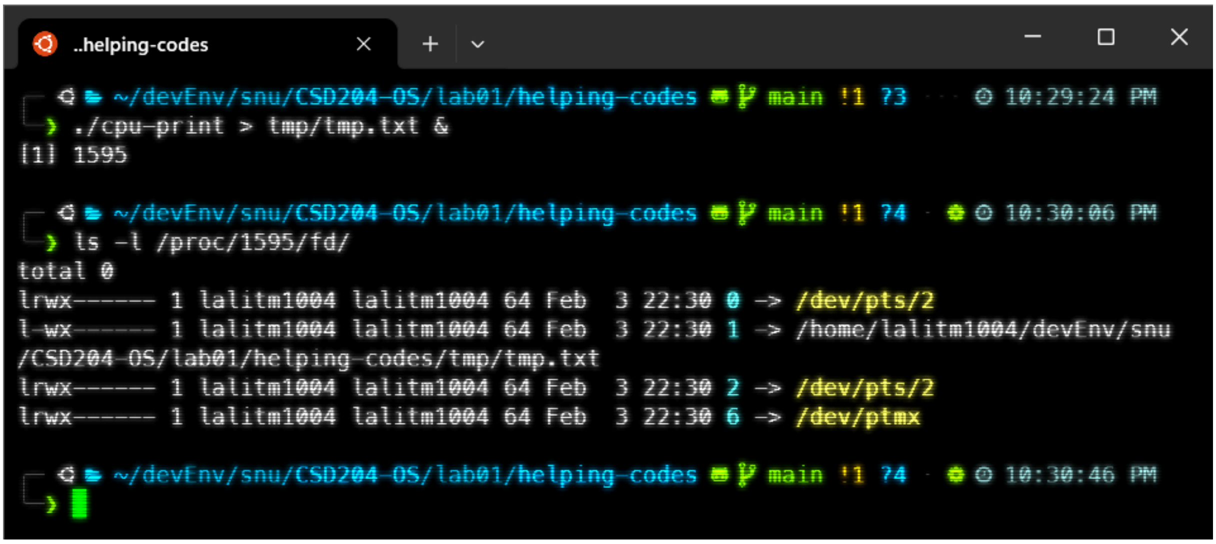
Question 5

Part A - B

```
ps -A | grep cpu-print
 1350 pts/2    00:02:09 cpu-print

ps -f 1350
UID          PID    PPID  C STIME TTY      STAT   TIME CMD
lalitm1+    1350     498 64 22:21 pts/2    R+     2:17 ./cpu-print

ps -f 498
UID          PID    PPID  C STIME TTY      STAT   TIME CMD
lalitm1+     498     497  0 21:19 pts/2    Ss     0:01 -zsh

ps -f 497
UID          PID    PPID  C STIME TTY      STAT   TIME CMD
root         497     496  0 21:19 ?        S      0:15 /init

ps -f 496
UID          PID    PPID  C STIME TTY      STAT   TIME CMD
root         496       2  0 21:19 ?        Ss     0:00 /init

ps -f 2
UID          PID    PPID  C STIME TTY      STAT   TIME CMD
root           2       1  0 21:19 ?        Sl     0:00 /init

ps -f 1
UID          PID    PPID  C STIME TTY      STAT   TIME CMD
root           1       0  0 21:19 ?        Ss     0:00 /sbin/init

ps -f 0
error: process ID out of range
```

1. Compile and run the cpu-print program
2. Use `ps -A | grep cpu-print` to capture the relevant information.
3. Use recursive `ps -f <PPID>` until you reach PPID 0

Part C



We can inspect the file descriptors of the `cpu-print` program by using the command `ls -l /proc/<pid>/fd/`. This shows us the following:

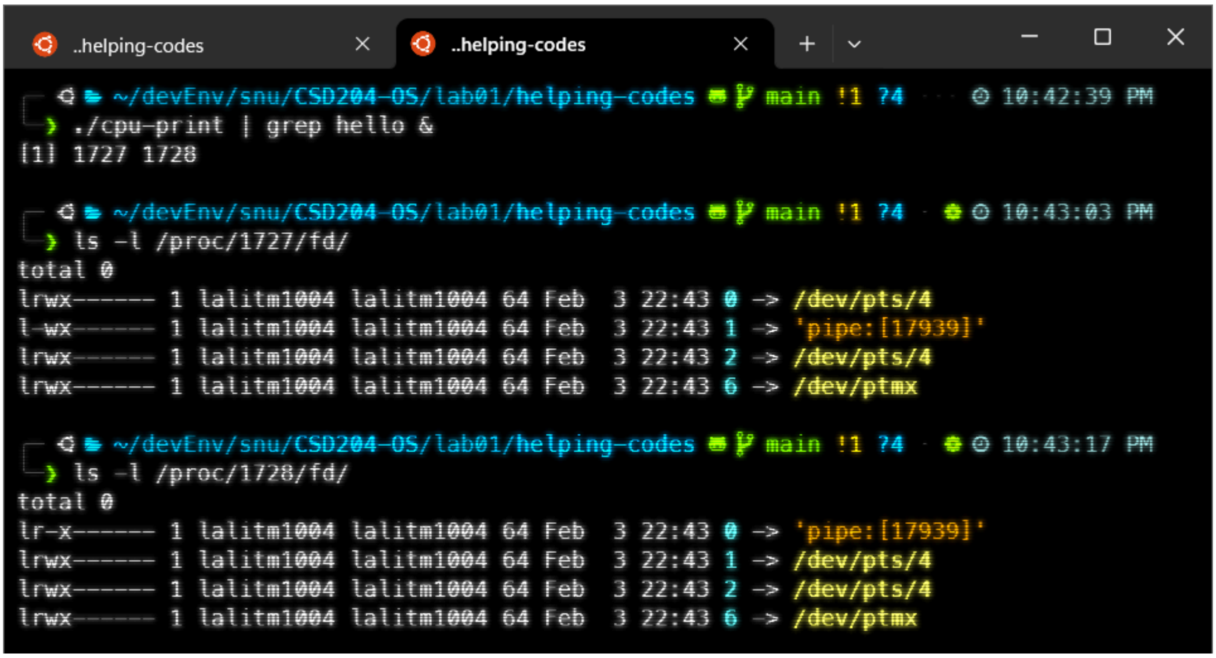
- File descriptor 0 (stdin): This will point to the terminal or other standard input source.
- File descriptor 1 (stdout): This will normally point to the terminal the process was executed in. But in this case, we have redirected it to the `.../tmp/tmp.txt` file.
- File descriptor 2 (stderr): This will point to the terminal and will route any errors there.

I/O redirection in the shell is achieved by manipulating the file descriptors (stdin, stdout, stderr) before the process is launched:

1. The shell closes the current standard output
2. The shell then opens the target file for writing and associates this with `fd 1`

The process does not need to know that its output is being redirected, it simply needs to write to its stdout.

Part D



The command spawns two new processes - `cpu-print` and `grep`. Like last time we can inspect their file descriptors using `ls -l /proc/<pid>/fd/`. We can see that the stdout of `cpu-print` was pointing to the stdin of `grep` via a pipe.

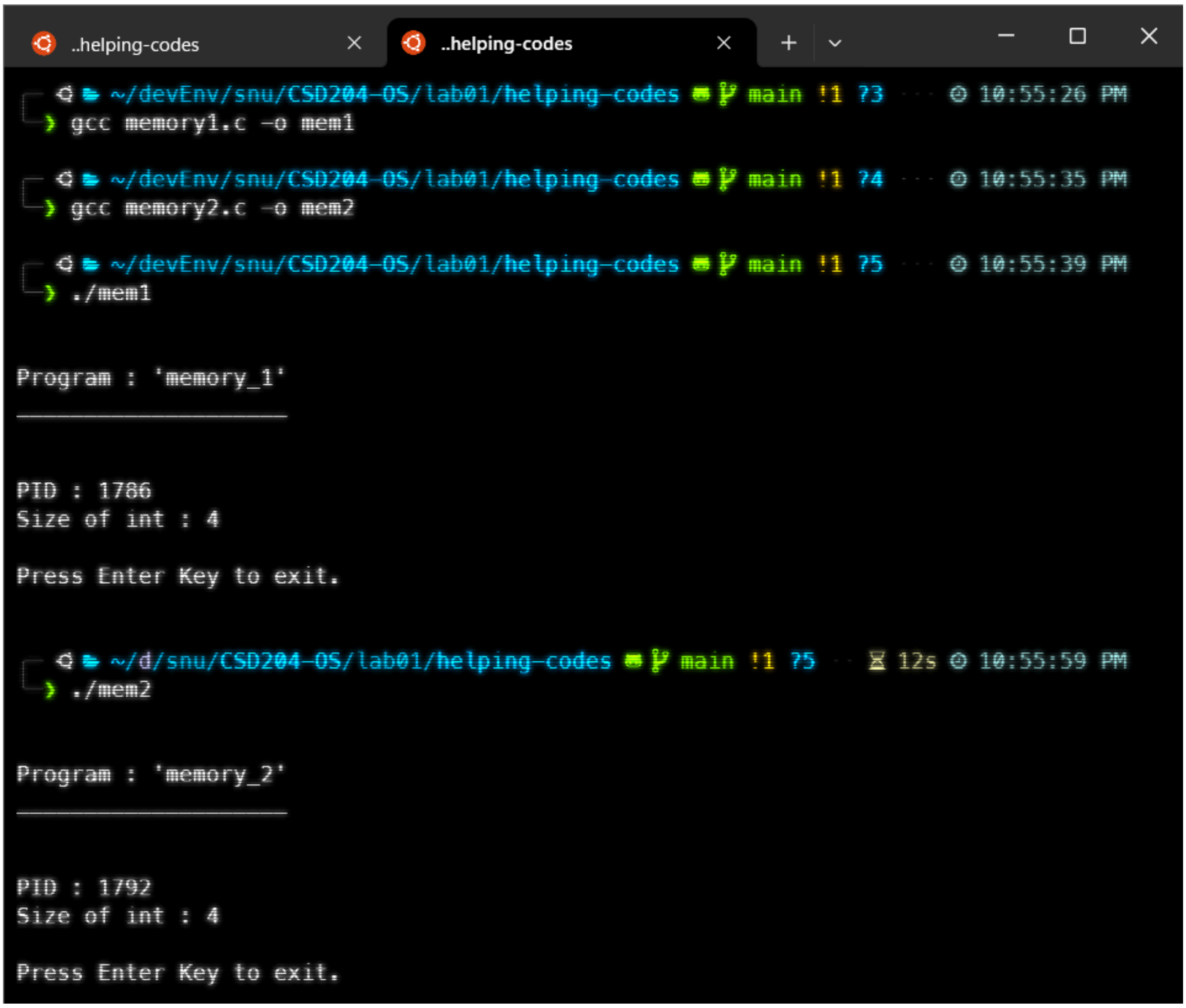
How the shell implements pipe:

1. Pipe creation: Before executing the command, the shell creates a pipe using the `pipe()` syscall. This results in a pair of file descriptors:
   - One for reading from the pipe
   - One for writing to the pipe
2. Redirection of file descriptors:
   - The stdout of `cpu-print` is redirected to the write end of the pipe.
   - The stdin of `grep` is redirected to the read end of the pipe.
3. Process execution: The shell then starts both processes.

Part E

Built In	External
• cd • history	• ls • ps

Question 6



```
~
ps u 1786                                                   10:55:17 PM
USER        PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
lalitm1+   1786  0.0  0.0   6464  4856 pts/4    S+   22:55   0:00 ./mem1

ps u 1792                                                   10:55:53 PM
USER        PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
lalitm1+   1792  0.0  0.0   6472  5488 pts/4    S+   22:56   0:00 ./mem2
```

The commands are executed in the order:

1. `./mem1`
2. `ps u <pid mem1>`
3. Exit `mem1`
4. `./mem2`
5. `ps u <pid mem2>`
6. Exit `mem2`

The Virtual memory of both programs is almost the same while the Resident Set Size or the physical memory is larger in `mem2`. This is because of the array access done in `mem2`.As a result, more of the allocated memory is loaded into the physical RAM resulting in a higher RSS.

Note that I am using WSL for Windows. On a dual booted system with ubuntu installed, the RSS of `mem2` is several times the RSS of `mem1`.

Question 7

Running disk.c

```
Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc              13.00         0.00        60.00         0.00          0         60          0

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc               2.00         0.00        12.00         0.00          0         12          0

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc            1401.00    130684.00         0.00         0.00     130684          0          0

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc            2662.00    248776.00         0.00         0.00     248776          0          0

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc            2704.00    252792.00         0.00         0.00     252792          0          0
```

In `disk.c`, we randomly choose to read a file from a sample of 5000. This results in practically zero rereads of a file. Which also means we see a consistent read amount when running `iostat -d 1`. This is cause we are not caching any files.

- Sustained kB_read/s of ~250000 kbs.

Running disk1.c

```
Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc               0.00         0.00         0.00         0.00          0          0          0


Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc              19.00      1044.00        32.00         0.00       1044         32          0


Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc               0.00         0.00         0.00         0.00          0          0          0


Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.00         0.00         0.00         0.00          0          0          0
sdb               0.00         0.00         0.00         0.00          0          0          0
sdc               0.00         0.00         0.00         0.00          0          0          0
```

In `disk1.c`, we repeatedly read from one singular file. Which results in on initial read logged in `iostat` with all concurrent logs reporting zero reads. This is because the system caches the file which saves time on rereads.

- Initial kB_read/s of 1044 Kbs which then falls to 0 due to caching.