DECS Assignment 01 :

Part 1) Introduction to linux tools Answers

Question 1) /proc filesystem

a) **Processors**: is a central processing unit of a computer which does all the computing work. It has arithmetic and logical units which computes arithmetic and logical instructions of programs given to it. It also manages control signals and I/O instructions.
Cores: CPU cores are the units inside CPU/ processors which process instructions and programs. A single process with multiple threads ideally runs faster on a multicore cpu.

b) 6 cores per processor.

c) My machine has 12 CPUs/processors.

d) Frequency of each processor (command is cat /proc/cpuinfo)
   i) Processor0 2200 MHz
   ii) processor1 1384 MHz
   iii) Processor 3 to 9 and 11 2200MHz
   iv) Processor10 3393 MHz

e) cpu architecture is x86_64

f) MemTotal: 16236148 kB (command is cat /proc/meminfo)

g) MemFree: 10384188 kB MemAvailable: 12933804 kB

h) No of processes created/forked since the boot 23076 (command used is cat /proc/stat) and no. of context switches voluntary_ctxt_switches: 703 nonvoluntary_ctxt_switches 10 (Command used us cat /proc/ $$/status)

Question 2)

1) PId of cpu process is 25951
2) 99.3% cpu and 2640 kb virtual and 972 physical memory this cpu process is consuming.
3) It is in Running state we can see it by using this command– cat /proc/25951/stat (25951 is PId here)

Question 3)

a)

- **PID –** is 19532 is unique process ID
- **TTY –** pts/0 is terminal type of user
- **TIME –** is 00:00:08 amount of CPU in minutes and seconds, process running
- **CMD –** cpu-print is the name of the command that launched the process.

b)

```
omkarkadam@omkarkadam:~$ pstree -aps 21077
systemd,1 splash
  └─systemd,1931 --user
      └─gnome-terminal-,19488
          └─bash,19506
              └─cpu-print,21077
```

c)

./cpu-print > /tmp/tmp.txt &

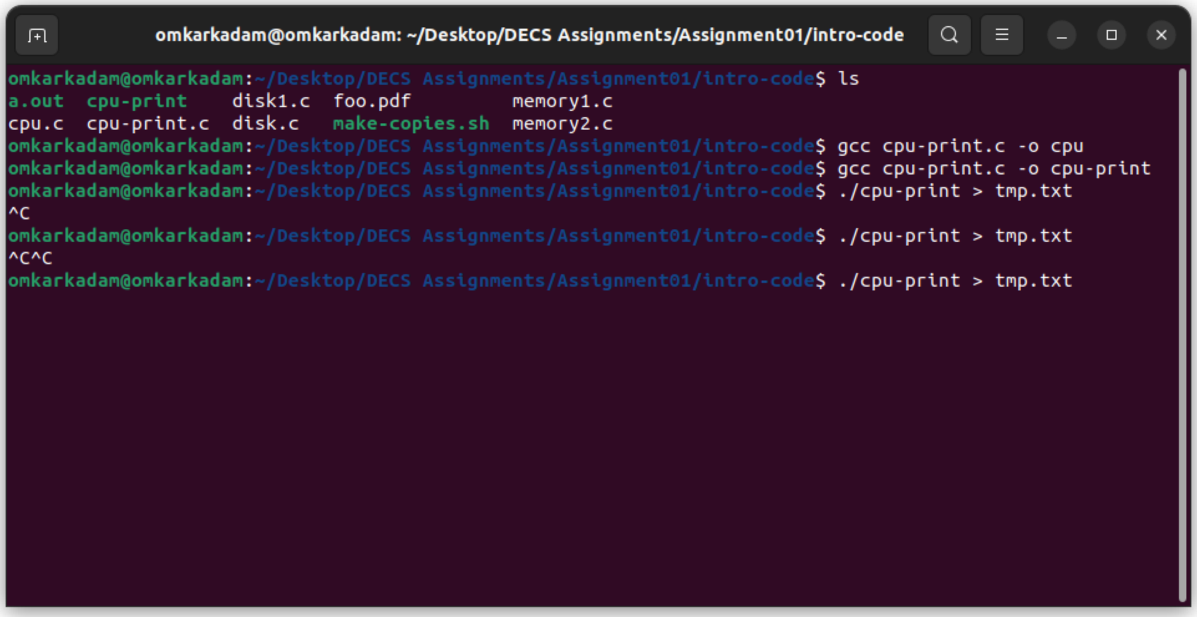
Above command will copy all the output after running cpu-print into the tmp.txt file; this is called IO redirection.

Now following command will give us pid of cpu print

ps -e | grep cpu-print

Now this will give us the file descriptor info of output.

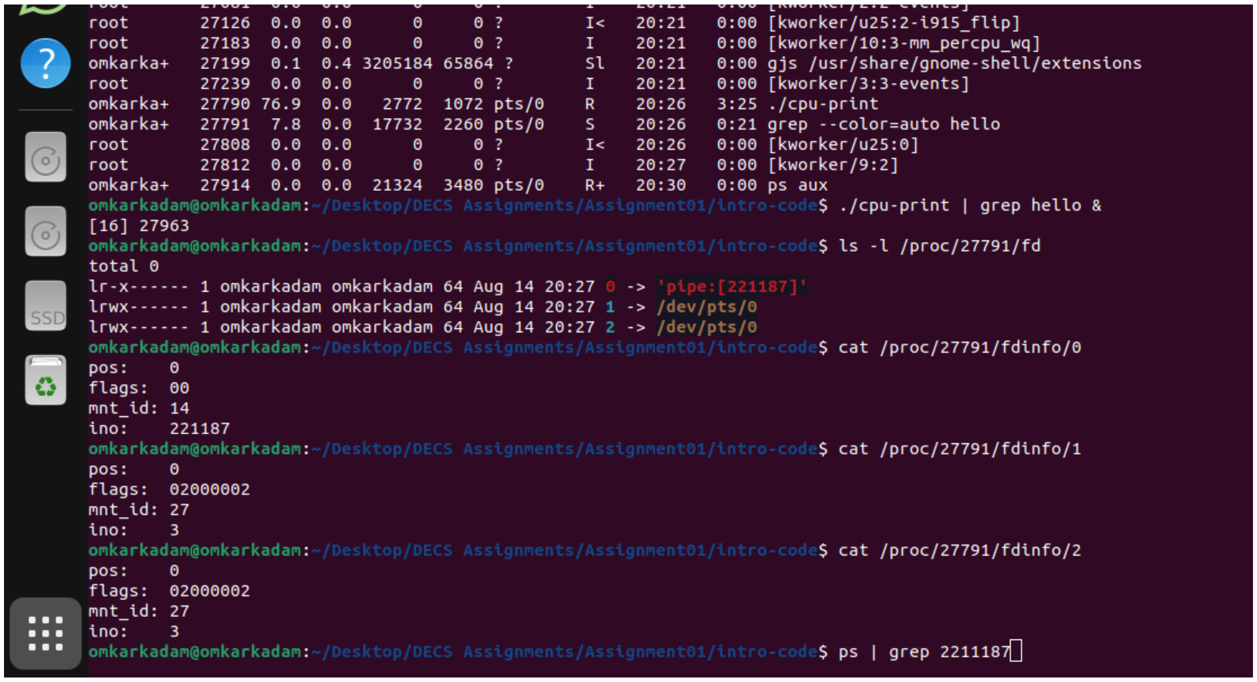
cat /proc/PID/fdinfo/1



```
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ ls
a.out  cpu-print    disk1.c  foo.pdf         memory1.c
cpu.c  cpu-print.c  disk.c   make-copies.sh  memory2.c
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ gcc cpu-print.c -o cpu
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ gcc cpu-print.c -o cpu-print
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ ./cpu-print > tmp.txt
^C
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ ./cpu-print > tmp.txt
^C^C
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ ./cpu-print > tmp.txt
```

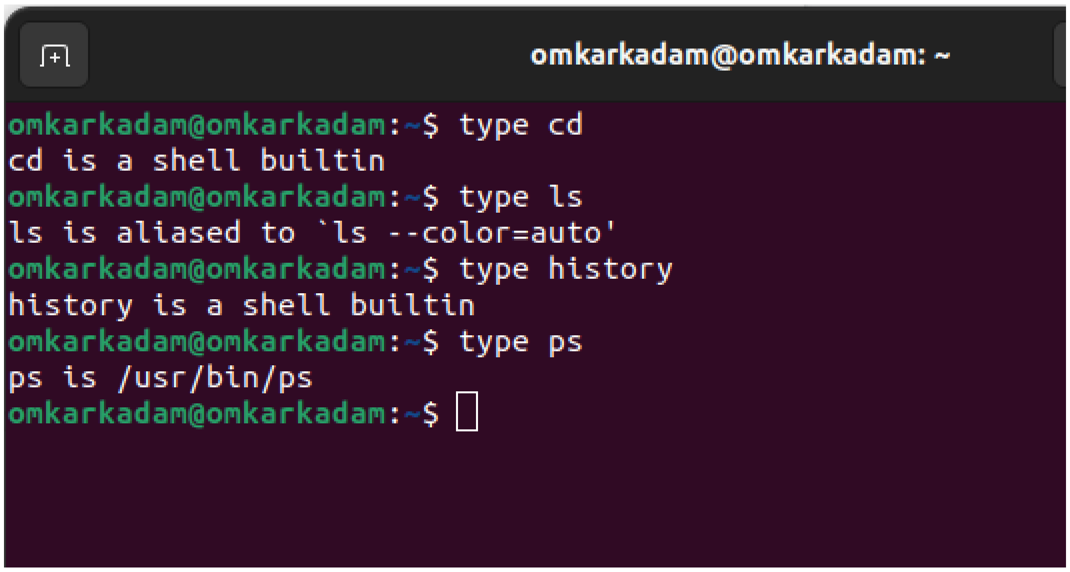
d)
./cpu-print | grep hello & gives the PID of this process.
 Now ls -l /proc/27791/fd will give us the user chmod modes time and where file descriptors (input,output,errors) are pointing to.

Piping helps to redirect one output to another destination, it helps combining two or more commands.



```
root        27126  0.0  0.0      0     0 ?        I<   20:21   0:00 [kworker/u25:2-i915_flip]
root        27183  0.0  0.0      0     0 ?        I    20:21   0:00 [kworker/10:3-mm_percpu_wq]
omkarka+    27199  0.1  0.4 3205184 65864 ?       Sl   20:21   0:00 gjs /usr/share/gnome-shell/extensions
root        27239  0.0  0.0      0     0 ?        I    20:21   0:00 [kworker/3:3-events]
omkarka+    27790 76.9  0.0   2772  1072 pts/0    R    20:26   3:25 ./cpu-print
omkarka+    27791  7.8  0.0  17732  2260 pts/0    S    20:26   0:21 grep --color=auto hello
root        27808  0.0  0.0      0     0 ?        I<   20:26   0:00 [kworker/u25:0]
root        27812  0.0  0.0      0     0 ?        I    20:27   0:00 [kworker/9:2]
omkarka+    27914  0.0  0.0  21324  3480 pts/0    R+   20:30   0:00 ps aux
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ ./cpu-print | grep hello &
[16] 27963
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ ls -l /proc/27791/fd
total 0
lr-x------ 1 omkarkadam omkarkadam 64 Aug 14 20:27 0 -> 'pipe:[221187]'
lrwx------ 1 omkarkadam omkarkadam 64 Aug 14 20:27 1 -> /dev/pts/0
lrwx------ 1 omkarkadam omkarkadam 64 Aug 14 20:27 2 -> /dev/pts/0
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ cat /proc/27791/fdinfo/0
pos:    0
flags:  00
mnt_id: 14
ino:    221187
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ cat /proc/27791/fdinfo/1
pos:    0
flags:  02000002
mnt_id: 27
ino:    3
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ cat /proc/27791/fdinfo/2
pos:    0
flags:  02000002
mnt_id: 27
ino:    3
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-code$ ps | grep 2211187
```

e) Cd and history are shell commands implemented in the kernel tree directory as a built in commands whereas ps and ls are not



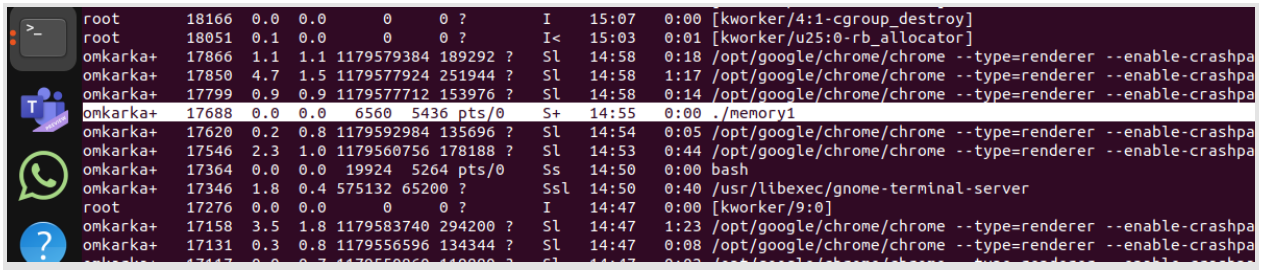
```
omkarkadam@omkarkadam:~$ type cd
cd is a shell builtin
omkarkadam@omkarkadam:~$ type ls
ls is aliased to `ls --color=auto'
omkarkadam@omkarkadam:~$ type history
history is a shell builtin
omkarkadam@omkarkadam:~$ type ps
ps is /usr/bin/ps
omkarkadam@omkarkadam:~$ 
```

Question 4)

Given two files memory1.c and memory2.c.
RSS is resident set size is like physical memory consumption and VSZ is virtual memory size.
`We use the following command to find RSS.`

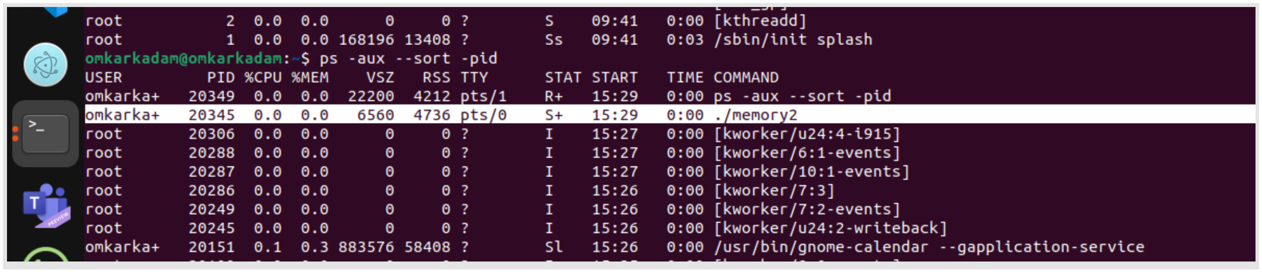
```
ps -aux
```

6560 Kbytes of virtual and 5436 Kbytes of physical memory is consumed by memory1 file



```
root        18166  0.0  0.0      0     0 ?        I    15:07   0:00 [kworker/4:1-cgroup_destroy]
root        18051  0.1  0.0      0     0 ?        I<   15:03   0:01 [kworker/u25:0-rb_allocator]
omkarka+    17866  1.1  1.1 1179579384 189292 ?   Sl   14:58   0:18 /opt/google/chrome/chrome --type=renderer --enable-crashpa
omkarka+    17850  4.7  1.5 1179577924 251944 ?   Sl   14:58   1:17 /opt/google/chrome/chrome --type=renderer --enable-crashpa
omkarka+    17799  0.9  0.9 1179577712 153976 ?   Sl   14:58   0:14 /opt/google/chrome/chrome --type=renderer --enable-crashpa
omkarka+    17688  0.0  0.0   6560  5436 pts/0    S+   14:55   0:00 ./memory1
omkarka+    17620  0.2  0.8 1179592984 135696 ?   Sl   14:54   0:05 /opt/google/chrome/chrome --type=renderer --enable-crashpa
omkarka+    17546  2.3  1.0 1179560756 178188 ?   Sl   14:53   0:44 /opt/google/chrome/chrome --type=renderer --enable-crashpa
omkarka+    17364  0.0  0.0  19924  5264 pts/0    Ss   14:50   0:00 bash
omkarka+    17346  1.8  0.4 575132 65200 ?        Ssl  14:50   0:40 /usr/libexec/gnome-terminal-server
root        17276  0.0  0.0      0     0 ?        I    14:47   0:00 [kworker/9:0]
omkarka+    17158  3.5  1.8 1179583740 294200 ?   Sl   14:47   1:23 /opt/google/chrome/chrome --type=renderer --enable-crashpa
omkarka+    17131  0.3  0.8 1179556596 134344 ?   Sl   14:47   0:08 /opt/google/chrome/chrome --type=renderer --enable-crashpa
```

6560 Kbytes of virtual and 4736 Kbytes of physical memory is consumed by memory2 file



```
root            2  0.0  0.0      0     0 ?        S    09:41   0:00 [kthreadd]
root            1  0.0  0.0 168196 13408 ?        Ss   09:41   0:03 /sbin/init splash
omkarkadam@omkarkadam:~$ ps -aux --sort -pid
USER          PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
omkarka+    20349  0.0  0.0  22200  4212 pts/1    R+   15:29   0:00 ps -aux --sort -pid
omkarka+    20345  0.0  0.0   6560  4736 pts/0    S+   15:29   0:00 ./memory2
root        20306  0.0  0.0      0     0 ?        I    15:27   0:00 [kworker/u24:4-i915]
root        20288  0.0  0.0      0     0 ?        I    15:27   0:00 [kworker/6:1-events]
root        20287  0.0  0.0      0     0 ?        I    15:27   0:00 [kworker/10:1-events]
root        20286  0.0  0.0      0     0 ?        I    15:26   0:00 [kworker/7:3]
root        20249  0.0  0.0      0     0 ?        I    15:26   0:00 [kworker/7:2-events]
root        20245  0.0  0.0      0     0 ?        I    15:26   0:00 [kworker/u24:2-writeback]
omkarka+    20151  0.1  0.3 883576 58408 ?        Sl   15:26   0:00 /usr/bin/gnome-calendar --gapplication-service
```

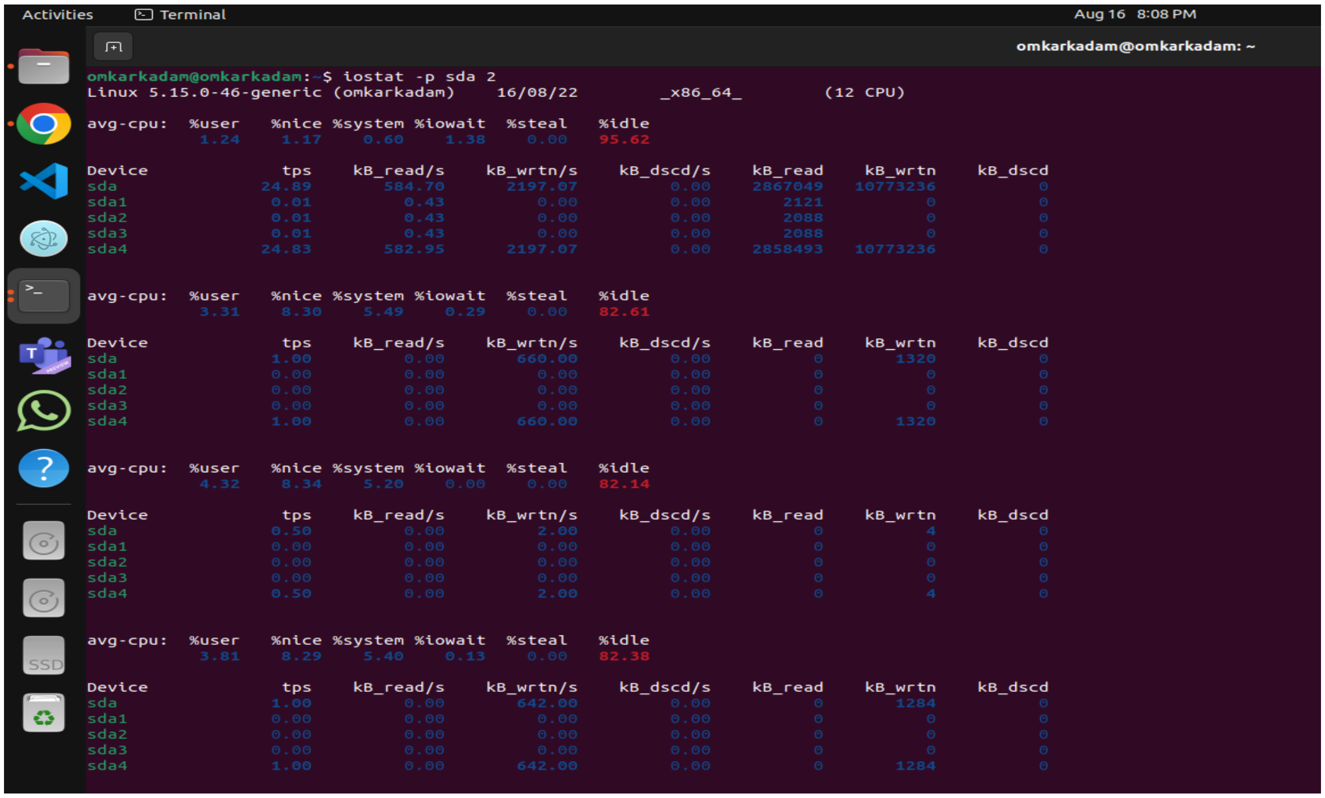
Virtual memory consumed by both the programs is the same.
Physical memory consumed by memory1.c (where array elements are not accessed and refilled) is more compared to memory2.

Question 5)

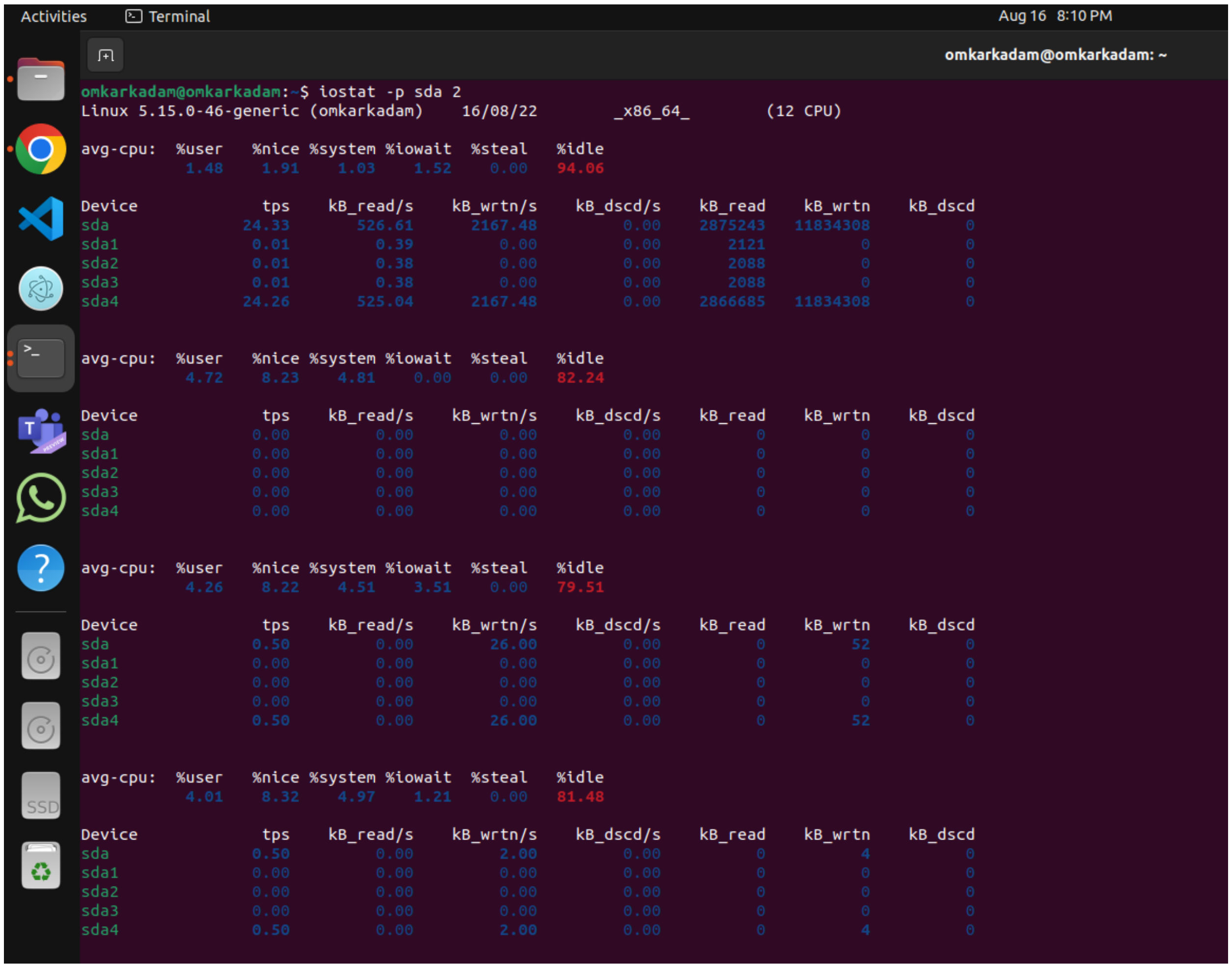
We do ./make-copies.sh to create 5000 files and then run the disk.c and disk1.c files.
Then we do this command for both the files.

$ iostat -p sda 2

It will show input output statistics of all partitions after every two seconds of interval.



```
omkarkadam@omkarkadam:~$ iostat -p sda 2
Linux 5.15.0-46-generic (omkarkadam)    16/08/22        _x86_64_        (12 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.24    1.17    0.60    1.38    0.00   95.62

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda              24.89       584.70      2197.07         0.00    2867049   10773236          0
sda1              0.01         0.43         0.00         0.00       2121          0          0
sda2              0.01         0.43         0.00         0.00       2088          0          0
sda3              0.01         0.43         0.00         0.00       2088          0          0
sda4             24.83       582.95      2197.07         0.00    2858493   10773236          0


avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           3.31    8.30    5.49    0.29    0.00   82.61

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               1.00         0.00       660.00         0.00          0       1320          0
sda1              0.00         0.00         0.00         0.00          0          0          0
sda2              0.00         0.00         0.00         0.00          0          0          0
sda3              0.00         0.00         0.00         0.00          0          0          0
sda4              1.00         0.00       660.00         0.00          0       1320          0


avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           4.32    8.34    5.20    0.00    0.00   82.14

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.50         0.00         2.00         0.00          0          4          0
sda1              0.00         0.00         0.00         0.00          0          0          0
sda2              0.00         0.00         0.00         0.00          0          0          0
sda3              0.00         0.00         0.00         0.00          0          0          0
sda4              0.50         0.00         2.00         0.00          0          4          0


avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           3.81    8.29    5.40    0.13    0.00   82.38

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               1.00         0.00       642.00         0.00          0       1284          0
sda1              0.00         0.00         0.00         0.00          0          0          0
sda2              0.00         0.00         0.00         0.00          0          0          0
sda3              0.00         0.00         0.00         0.00          0          0          0
sda4              1.00         0.00       642.00         0.00          0       1284          0
```



Activities   Terminal   Aug 16 8:10 PM

omkarkadam@omkarkadam: ~

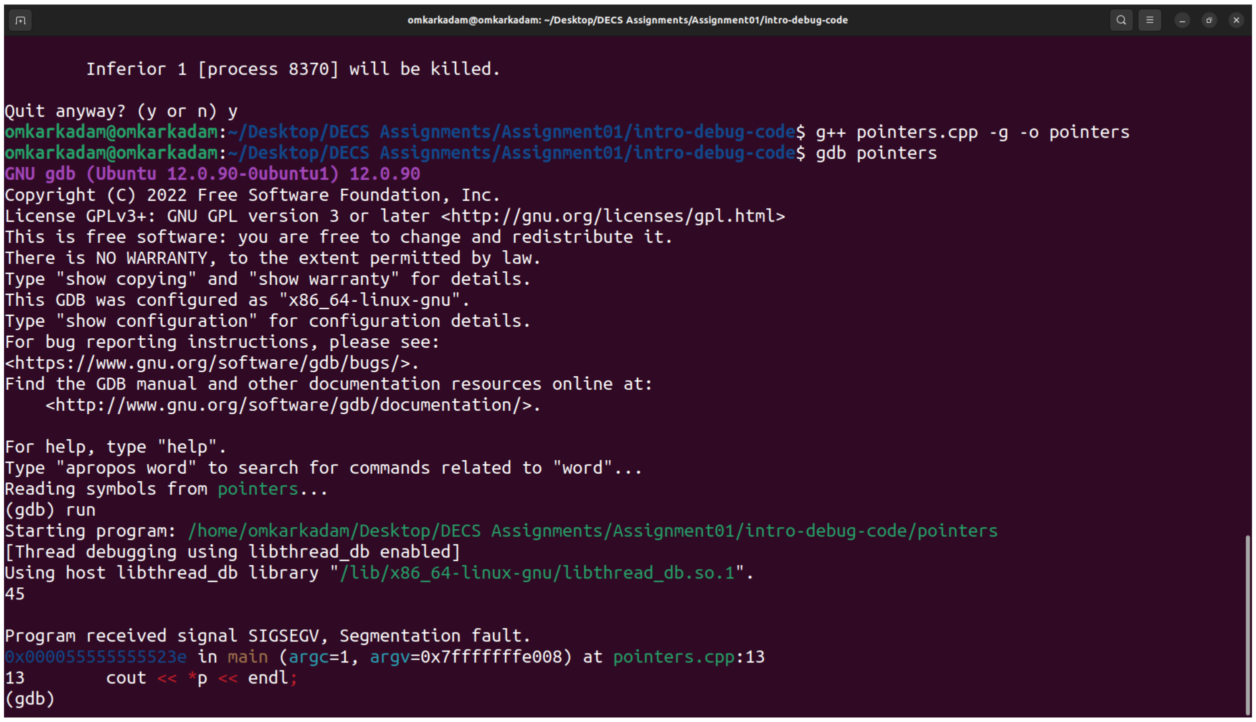
```
omkarkadam@omkarkadam:~$ iostat -p sda 2
Linux 5.15.0-46-generic (omkarkadam)    16/08/22        _x86_64_        (12 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.48    1.91    1.03    1.52    0.00   94.06

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda              24.33       526.61      2167.48         0.00    2875243   11834308          0
sda1              0.01         0.39         0.00         0.00       2121          0          0
sda2              0.01         0.38         0.00         0.00       2088          0          0
sda3              0.01         0.38         0.00         0.00       2088          0          0
sda4             24.26       525.04      2167.48         0.00    2866685   11834308          0


avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           4.72    8.23    4.81    0.00    0.00   82.24

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
sda1              0.00         0.00         0.00         0.00          0          0          0
sda2              0.00         0.00         0.00         0.00          0          0          0
sda3              0.00         0.00         0.00         0.00          0          0          0
sda4              0.00         0.00         0.00         0.00          0          0          0


avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           4.26    8.22    4.51    3.51    0.00   79.51

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.50         0.00        26.00         0.00          0         52          0
sda1              0.00         0.00         0.00         0.00          0          0          0
sda2              0.00         0.00         0.00         0.00          0          0          0
sda3              0.00         0.00         0.00         0.00          0          0          0
sda4              0.50         0.00        26.00         0.00          0         52          0


avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           4.01    8.32    4.97    1.21    0.00   81.48

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.50         0.00         2.00         0.00          0          4          0
sda1              0.00         0.00         0.00         0.00          0          0          0
sda2              0.00         0.00         0.00         0.00          0          0          0
sda3              0.00         0.00         0.00         0.00          0          0          0
sda4              0.50         0.00         2.00         0.00          0          4          0
```

Part 2) Introduction to debugging tool

Part A) Debugging with GDB

Question 1)

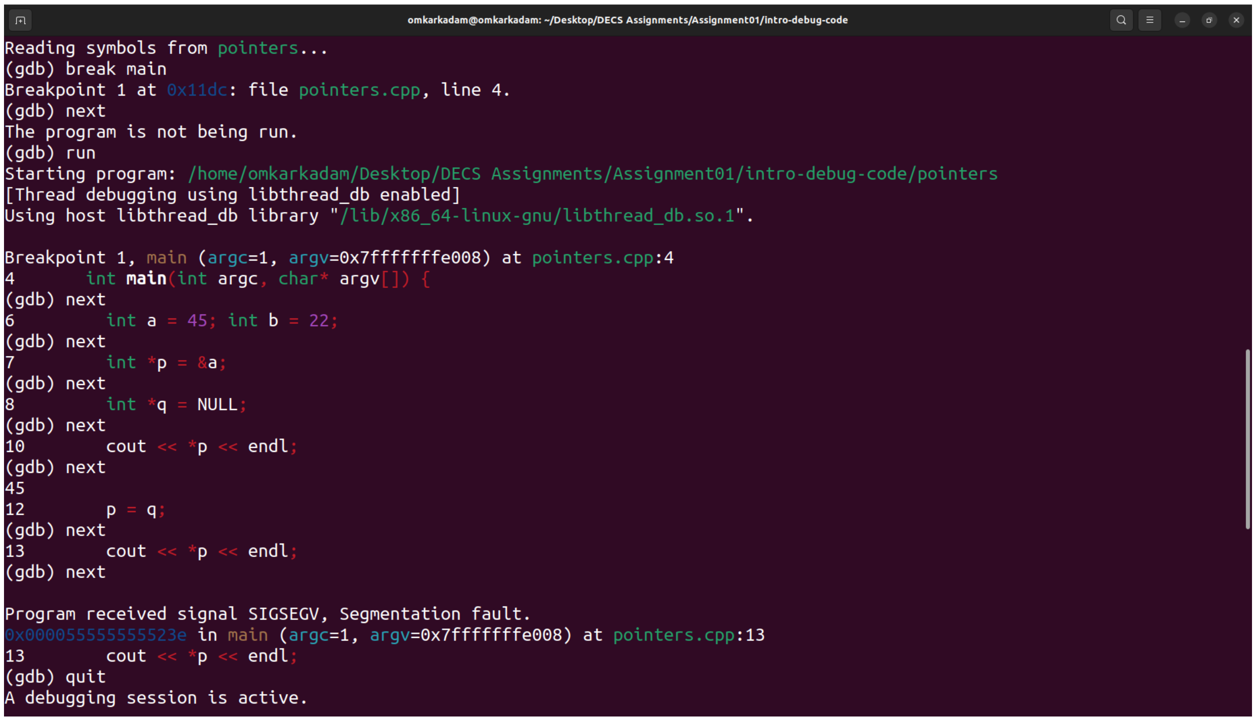
One option to find the segmentation fault in pointers.cpp is run its object file in gdb (first do (1)g++ pointers -g -o pointers 2)gdb pointers) and then type run command in gdb it will print the message “ segmentation error on line 13”



```
omkarkadam@omkarkadam: ~/Desktop/DECS Assignments/Assignment01/intro-debug-code

        Inferior 1 [process 8370] will be killed.

Quit anyway? (y or n) y
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-debug-code$ g++ pointers.cpp -g -o pointers
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-debug-code$ gdb pointers
GNU gdb (Ubuntu 12.0.90-0ubuntu1) 12.0.90
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from pointers...
(gdb) run
Starting program: /home/omkarkadam/Desktop/DECS Assignments/Assignment01/intro-debug-code/pointers
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
45

Program received signal SIGSEGV, Segmentation fault.
0x000055555555523e in main (argc=1, argv=0x7fffffffe008) at pointers.cpp:13
13        cout << *p << endl;
(gdb)
```

Another way is if you use breakpoint on the main function and go step by step on the next line like shown below.

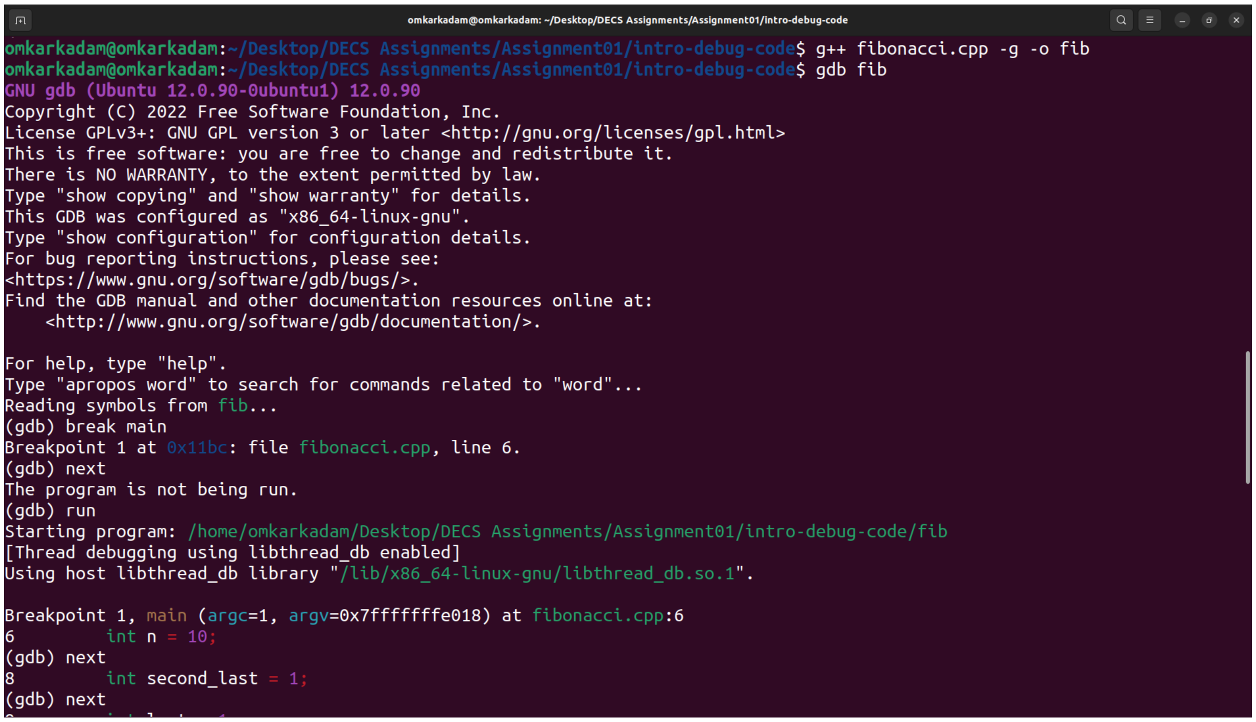
Program received signal SIGSEGV, Segmentation fault.
0x000055555555523e in main (argc=1, argv=0x7fffffffe008) at pointers.cpp:13
13   cout << *p << endl;


omkarkadam@omkarkadam: ~/Desktop/DECS Assignments/Assignment01/intro-debug-code

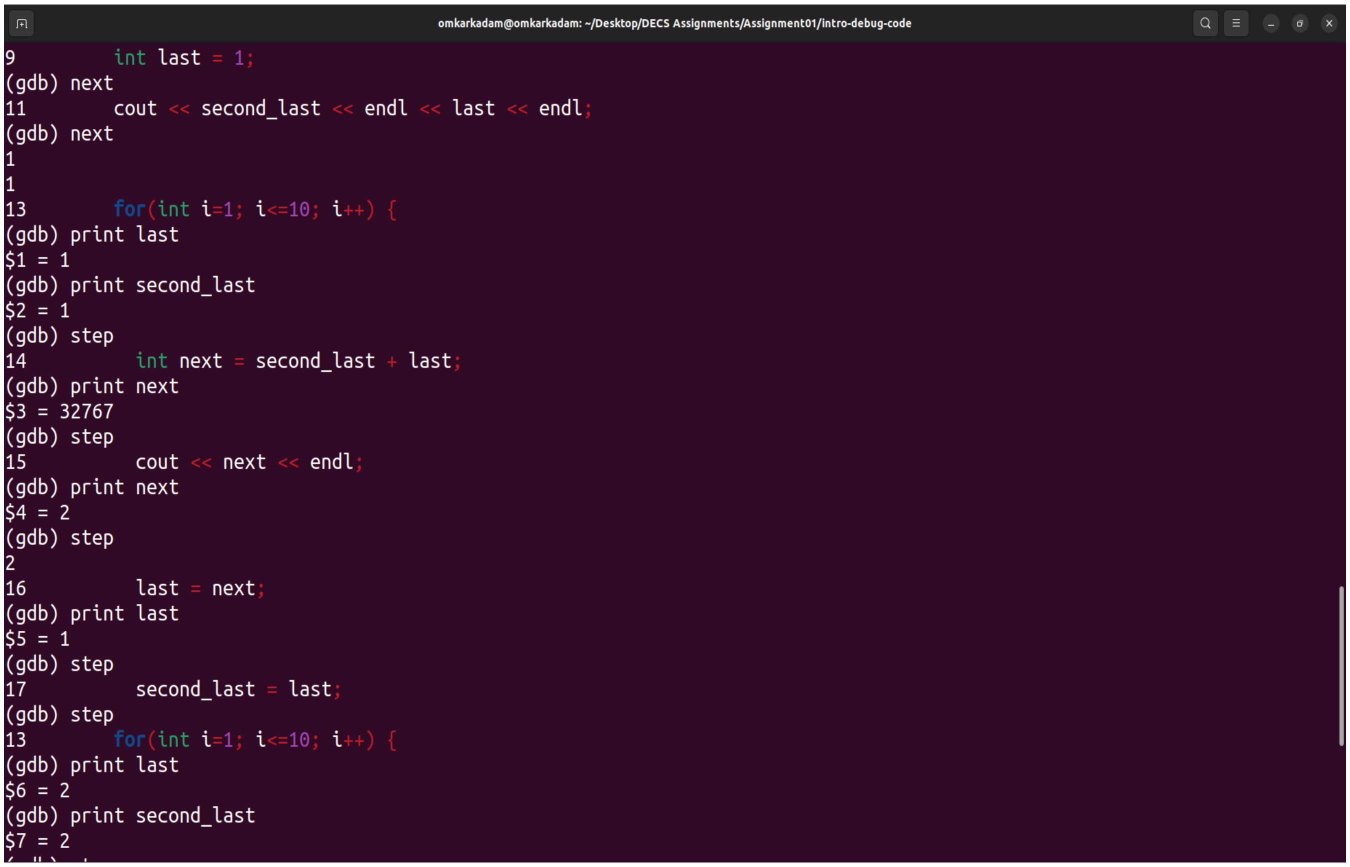
```
Reading symbols from pointers...
(gdb) break main
Breakpoint 1 at 0x11dc: file pointers.cpp, line 4.
(gdb) next
The program is not being run.
(gdb) run
Starting program: /home/omkarkadam/Desktop/DECS Assignments/Assignment01/intro-debug-code/pointers
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".

Breakpoint 1, main (argc=1, argv=0x7fffffffe008) at pointers.cpp:4
4       int main(int argc, char* argv[]) {
(gdb) next
6         int a = 45; int b = 22;
(gdb) next
7         int *p = &a;
(gdb) next
8         int *q = NULL;
(gdb) next
10        cout << *p << endl;
(gdb) next
45
12        p = q;
(gdb) next
13        cout << *p << endl;
(gdb) next

Program received signal SIGSEGV, Segmentation fault.
0x000055555555523e in main (argc=1, argv=0x7fffffffe008) at pointers.cpp:13
13        cout << *p << endl;
(gdb) quit
A debugging session is active.
```

Question 2)

1. Run the program in gdb as you did earlier.
2. Put a breakpoint on the main function. (break main).
3. Run the program and check the values of last and second_last variables after cout statements by these commands 1) print last 2)print second_last in gdb.
4. Command step for next line instruction.
5. Check the value of the next variable after the expression evaluation.
6. Go to the next steps till you enter the loop again.
7. Do check the values of last and second_last variables; they are the same.
8. Do step 56,7 one more time and you will find the same.
9. The value of next is first stored in last then value of last (which here now equals to value of next) is stored in second_last, in short the problem is we will have to exchange line 16 with line 17.


omkarkadam@omkarkadam: ~/Desktop/DECS Assignments/Assignment01/intro-debug-code

```
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-debug-code$ g++ fibonacci.cpp -g -o fib
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-debug-code$ gdb fib
GNU gdb (Ubuntu 12.0.90-0ubuntu1) 12.0.90
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from fib...
(gdb) break main
Breakpoint 1 at 0x11bc: file fibonacci.cpp, line 6.
(gdb) next
The program is not being run.
(gdb) run
Starting program: /home/omkarkadam/Desktop/DECS Assignments/Assignment01/intro-debug-code/fib
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".

Breakpoint 1, main (argc=1, argv=0x7fffffffe018) at fibonacci.cpp:6
6           int n = 10;
(gdb) next
8           int second_last = 1;
(gdb) next
```

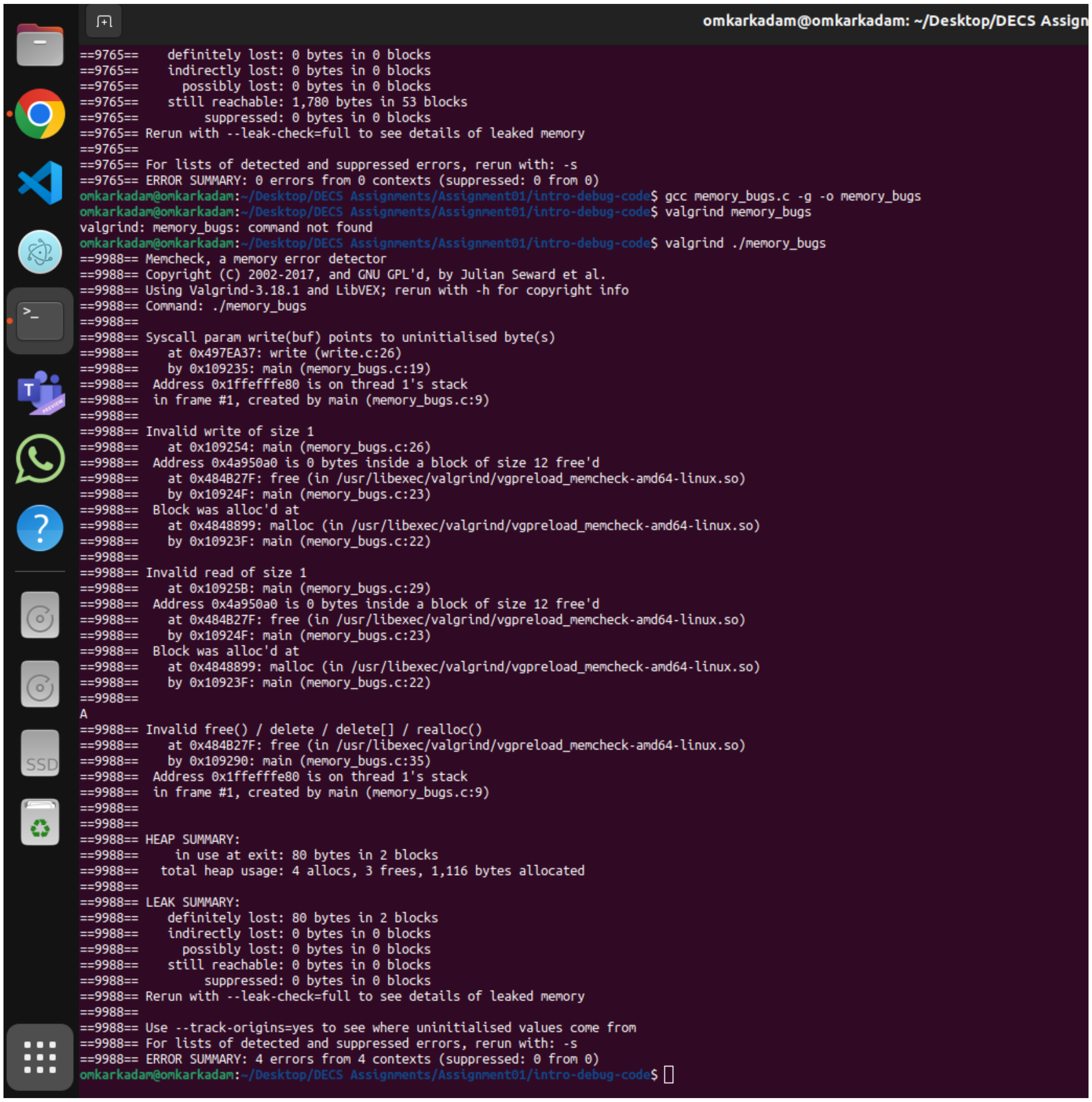

omkarkadam@omkarkadam: ~/Desktop/DECS Assignments/Assignment01/intro-debug-code

```
9         int last = 1;
(gdb) next
11        cout << second_last << endl << last << endl;
(gdb) next
1
1
13        for(int i=1; i<=10; i++) {
(gdb) print last
$1 = 1
(gdb) print second_last
$2 = 1
(gdb) step
14          int next = second_last + last;
(gdb) print next
$3 = 32767
(gdb) step
15          cout << next << endl;
(gdb) print next
$4 = 2
(gdb) step
2
16          last = next;
(gdb) print last
$5 = 1
(gdb) step
17          second_last = last;
(gdb) step
13        for(int i=1; i<=10; i++) {
(gdb) print last
$6 = 2
(gdb) print second_last
$7 = 2
```

Part B) Memory Check with Valgrind

Question 1) Exercise

Total of 80 bytes (in allocation blocks) of memory leakage and one invalid free operation is noticed. Int arr[10] is allocated in stack area hence it does not need to be freed/released explicitly (showing invalid free error) whereas malloc allocated memory in heap area so it has to be freed explicitly. Allocation 1 of 30 bytes and allocation 3 of 50 bytes is however not freed explicitly hence wasted.
Invalid write error is due to pointer p pointing to null location and we were assigning ‘A’ to it.



```
==9765==    definitely lost: 0 bytes in 0 blocks
==9765==    indirectly lost: 0 bytes in 0 blocks
==9765==      possibly lost: 0 bytes in 0 blocks
==9765==    still reachable: 1,780 bytes in 53 blocks
==9765==         suppressed: 0 bytes in 0 blocks
==9765== Rerun with --leak-check=full to see details of leaked memory
==9765==
==9765== For lists of detected and suppressed errors, rerun with: -s
==9765== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-debug-code$ gcc memory_bugs.c -g -o memory_bugs
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-debug-code$ valgrind memory_bugs
valgrind: memory_bugs: command not found
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-debug-code$ valgrind ./memory_bugs
==9988== Memcheck, a memory error detector
==9988== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==9988== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==9988== Command: ./memory_bugs
==9988==
==9988== Syscall param write(buf) points to uninitialised byte(s)
==9988==    at 0x497EA37: write (write.c:26)
==9988==    by 0x109235: main (memory_bugs.c:19)
==9988==  Address 0x1ffefffe80 is on thread 1's stack
==9988==  in frame #1, created by main (memory_bugs.c:9)
==9988==
==9988== Invalid write of size 1
==9988==    at 0x109254: main (memory_bugs.c:26)
==9988==  Address 0x4a950a0 is 0 bytes inside a block of size 12 free'd
==9988==    at 0x484B27F: free (in /usr/libexec/valgrind/vgpreload_memcheck-amd64-linux.so)
==9988==    by 0x10924F: main (memory_bugs.c:23)
==9988==  Block was alloc'd at
==9988==    at 0x4848899: malloc (in /usr/libexec/valgrind/vgpreload_memcheck-amd64-linux.so)
==9988==    by 0x10923F: main (memory_bugs.c:22)
==9988==
==9988== Invalid read of size 1
==9988==    at 0x10925B: main (memory_bugs.c:29)
==9988==  Address 0x4a950a0 is 0 bytes inside a block of size 12 free'd
==9988==    at 0x484B27F: free (in /usr/libexec/valgrind/vgpreload_memcheck-amd64-linux.so)
==9988==    by 0x10924F: main (memory_bugs.c:23)
==9988==  Block was alloc'd at
==9988==    at 0x4848899: malloc (in /usr/libexec/valgrind/vgpreload_memcheck-amd64-linux.so)
==9988==    by 0x10923F: main (memory_bugs.c:22)
==9988==
A
==9988== Invalid free() / delete / delete[] / realloc()
==9988==    at 0x484B27F: free (in /usr/libexec/valgrind/vgpreload_memcheck-amd64-linux.so)
==9988==    by 0x109290: main (memory_bugs.c:35)
==9988==  Address 0x1ffefffe80 is on thread 1's stack
==9988==  in frame #1, created by main (memory_bugs.c:9)
==9988==
==9988==
==9988== HEAP SUMMARY:
==9988==     in use at exit: 80 bytes in 2 blocks
==9988==   total heap usage: 4 allocs, 3 frees, 1,116 bytes allocated
==9988==
==9988== LEAK SUMMARY:
==9988==    definitely lost: 80 bytes in 2 blocks
==9988==    indirectly lost: 0 bytes in 0 blocks
==9988==      possibly lost: 0 bytes in 0 blocks
==9988==    still reachable: 0 bytes in 0 blocks
==9988==         suppressed: 0 bytes in 0 blocks
==9988== Rerun with --leak-check=full to see details of leaked memory
==9988==
==9988== Use --track-origins=yes to see where uninitialised values come from
==9988== For lists of detected and suppressed errors, rerun with: -s
==9988== ERROR SUMMARY: 4 errors from 4 contexts (suppressed: 0 from 0)
omkarkadam@omkarkadam:~/Desktop/DECS Assignments/Assignment01/intro-debug-code$
```

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