



National Textile University

Department of Computer Science

Subject

Operating System

Submitted to:

Sir Nasir

Submitted by:

Haider Ali

Registration Number

23-NTU-CS-1164

Lab No.

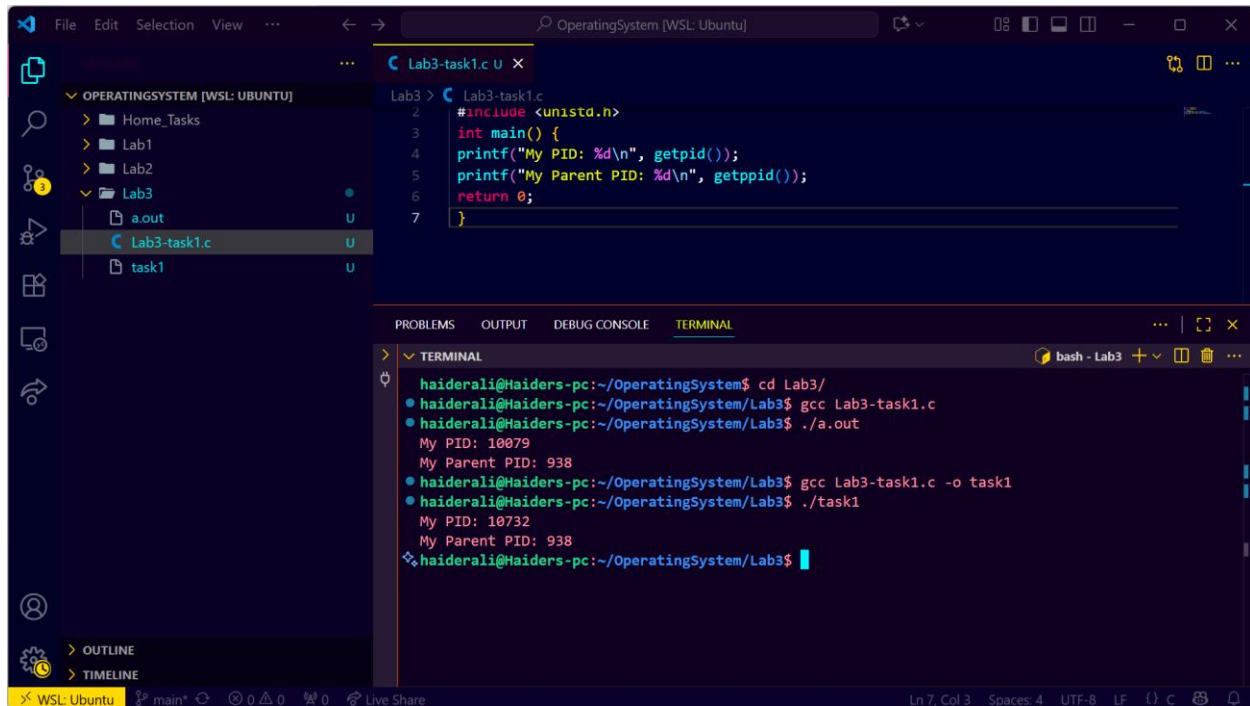
03

Semester

5th

C Programs on Processes

Program 1: Print PID and PPID:



The screenshot shows a Visual Studio Code editor window with a file explorer on the left, a code editor in the center, and a terminal at the bottom. The file explorer shows a project structure with folders 'Home_Tasks', 'Lab1', 'Lab2', and 'Lab3'. Inside 'Lab3', there are files 'a.out', 'Lab3-task1.c', and 'task1'. The code editor displays the content of 'Lab3-task1.c', which is a C program that prints its own PID and its parent's PID (PPID). The terminal shows the execution of the program, with the output 'My PID: 10079' and 'My Parent PID: 938'.

```
File Edit Selection View ... OperatingSystem [WSL: Ubuntu]
Lab3-task1.c U
Lab3 > C Lab3-task1.c
2 #include <unistd.h>
3 int main() {
4     printf("My PID: %d\n", getpid());
5     printf("My Parent PID: %d\n", getppid());
6     return 0;
7 }

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
> TERMINAL bash - Lab3
haiderali@Haider-pc:~/OperatingSystem$ cd Lab3/
haiderali@Haider-pc:~/OperatingSystem/Lab3$ gcc Lab3-task1.c
haiderali@Haider-pc:~/OperatingSystem/Lab3$ ./a.out
My PID: 10079
My Parent PID: 938
haiderali@Haider-pc:~/OperatingSystem/Lab3$ gcc Lab3-task1.c -o task1
haiderali@Haider-pc:~/OperatingSystem/Lab3$ ./task1
My PID: 10732
My Parent PID: 938
haiderali@Haider-pc:~/OperatingSystem/Lab3$
```

Program 2: Fork – Creating Child Process:

```
Lab3 > Lab3-task2.c
8  } else {
9  // This block runs in the parent process
10 printf("Parent: PID=%d, Child=%d\n", getpid(), pid);
11 }
12 return 0;
13 }
```

```
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ gcc Lab3-task2.c
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ./a.out
Parent: PID=19168, Child=19169
Child: PID=19169, Parent=19168
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ gcc Lab3-task2.c -o simple-process
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ./simple-process
Parent: PID=19298, Child=19299
Child: PID=19299, Parent=19298
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$
```

Program 3: Execl – Replacing a Process:

```
Lab3 > Lab3-task3.c
10 printf("Parent still running...\n");
11 }
12 return 0;
```

```
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ gcc Lab3-task3.c
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ./a.out
Parent still running...
total 60
-rw-r--r-- 1 haiderali haiderali 146 Oct 3 14:47 Lab3-task1.c
-rw-r--r-- 1 haiderali haiderali 315 Oct 3 15:43 Lab3-task2.c
-rw-r--r-- 1 haiderali haiderali 243 Oct 3 15:45 Lab3-task3.c
-rwxr-xr-x 1 haiderali haiderali 16048 Oct 3 15:45 a.out
-rwxr-xr-x 1 haiderali haiderali 16096 Oct 3 15:44 simple-process
-rwxr-xr-x 1 haiderali haiderali 16056 Oct 3 14:51 task1
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ gcc Lab3-task3.c -o without-wait
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ./without-wait
Parent still running...
total 76
-rw-r--r-- 1 haiderali haiderali 146 Oct 3 14:47 Lab3-task1.c
-rw-r--r-- 1 haiderali haiderali 315 Oct 3 15:43 Lab3-task2.c
-rw-r--r-- 1 haiderali haiderali 243 Oct 3 15:45 Lab3-task3.c
-rwxr-xr-x 1 haiderali haiderali 16048 Oct 3 15:45 a.out
-rwxr-xr-x 1 haiderali haiderali 16096 Oct 3 15:44 simple-process
-rwxr-xr-x 1 haiderali haiderali 16056 Oct 3 14:51 task1
-rwxr-xr-x 1 haiderali haiderali 16048 Oct 3 15:46 without-wait
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$
```

Program 4: Wait – Synchronization:

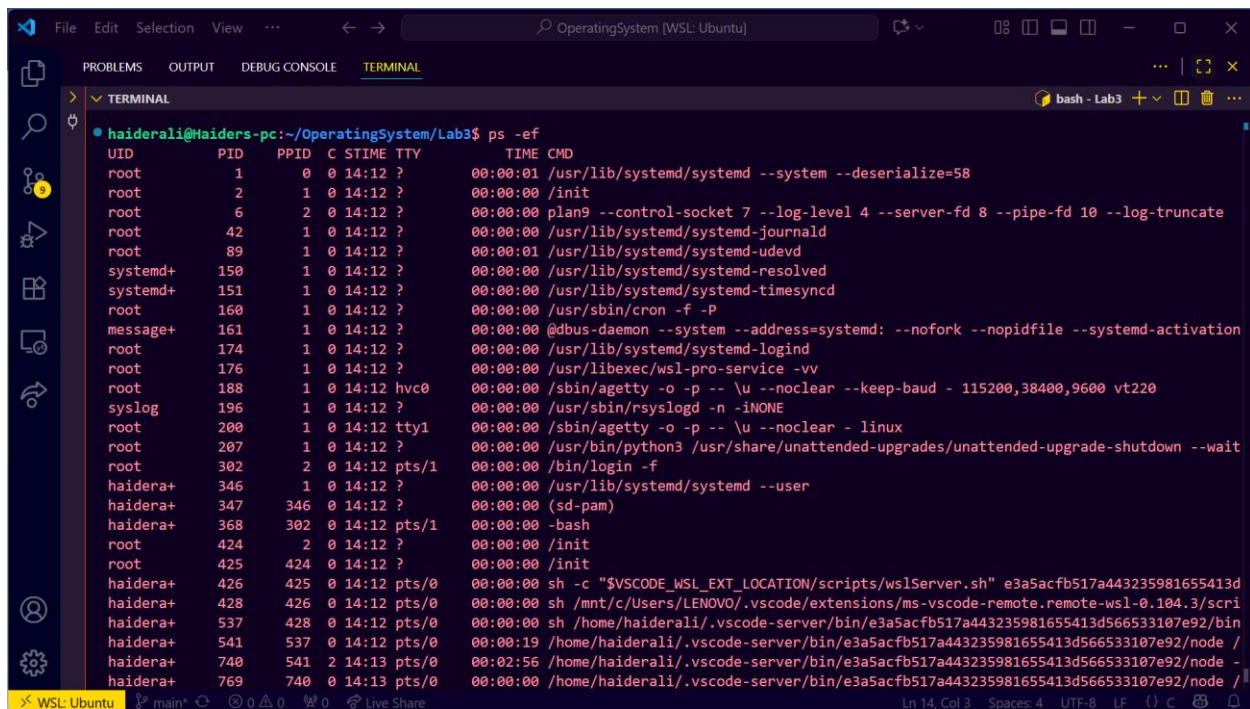
```
Lab3 > Lab3-task4.c
1 #include <stdio.h>

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
TERMINAL
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ gcc Lab3-task4.c
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ./a.out
total 80
-rw-r--r-- 1 haiderali haiderali 146 Oct 3 14:47 Lab3-task1.c
-rw-r--r-- 1 haiderali haiderali 315 Oct 3 15:49 Lab3-task2.c
-rw-r--r-- 1 haiderali haiderali 242 Oct 3 15:49 Lab3-task3.c
-rw-r--r-- 1 haiderali haiderali 328 Oct 3 15:52 Lab3-task4.c
-rwxr-xr-x 1 haiderali haiderali 16096 Oct 3 15:53 a.out
-rwxr-xr-x 1 haiderali haiderali 16096 Oct 3 15:44 simple-process
-rwxr-xr-x 1 haiderali haiderali 16056 Oct 3 14:51 task1
-rwxr-xr-x 1 haiderali haiderali 16048 Oct 3 15:50 without-wait
Parent still running...
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ gcc Lab3-task4.c -o wait
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ./wait
total 96
-rw-r--r-- 1 haiderali haiderali 146 Oct 3 14:47 Lab3-task1.c
-rw-r--r-- 1 haiderali haiderali 315 Oct 3 15:49 Lab3-task2.c
-rw-r--r-- 1 haiderali haiderali 242 Oct 3 15:49 Lab3-task3.c
-rw-r--r-- 1 haiderali haiderali 328 Oct 3 15:52 Lab3-task4.c
-rwxr-xr-x 1 haiderali haiderali 16096 Oct 3 15:53 a.out
-rwxr-xr-x 1 haiderali haiderali 16096 Oct 3 15:44 simple-process
-rwxr-xr-x 1 haiderali haiderali 16056 Oct 3 14:51 task1
-rwxr-xr-x 1 haiderali haiderali 16096 Oct 3 15:53 wait
-rwxr-xr-x 1 haiderali haiderali 16048 Oct 3 15:50 without-wait
Parent still running...
```

ps → Process Status:

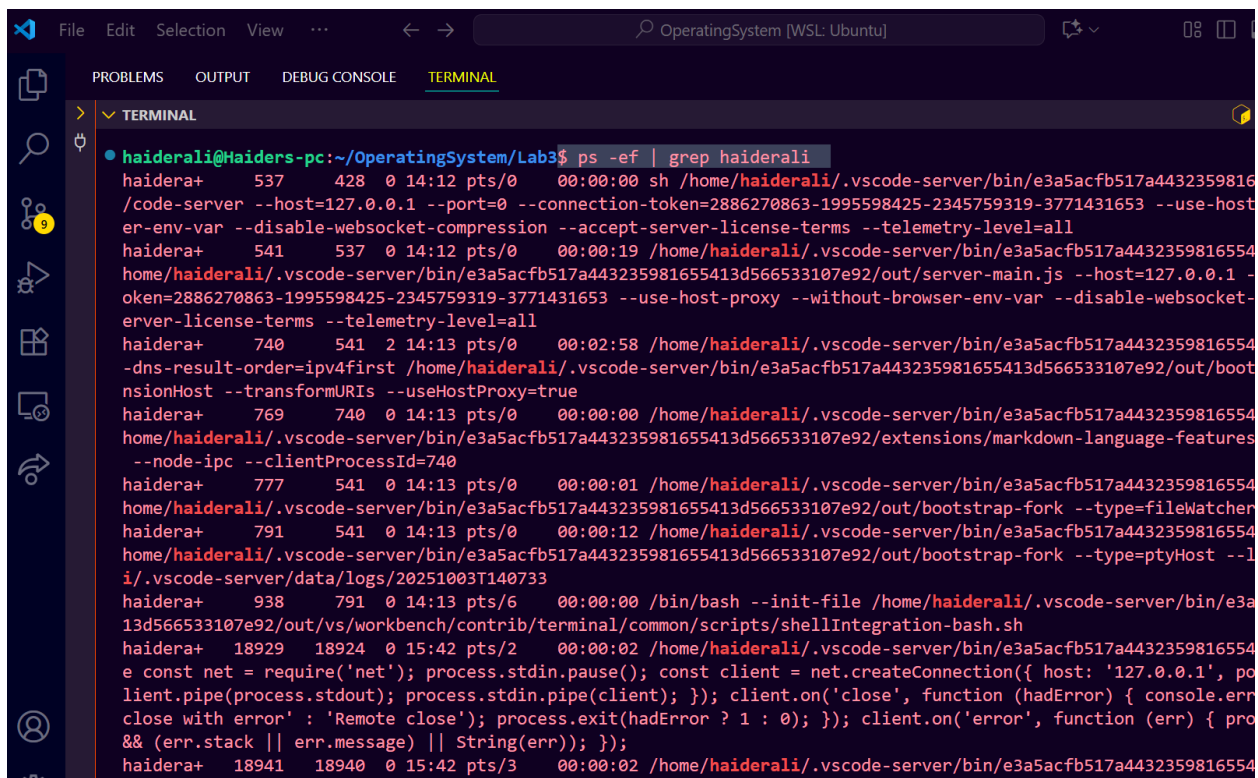
```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
TERMINAL
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ps
PID TTY TIME CMD
938 pts/6 00:00:00 bash
21072 pts/6 00:00:00 ps
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$
```

ps -ef → Full list of all processes:



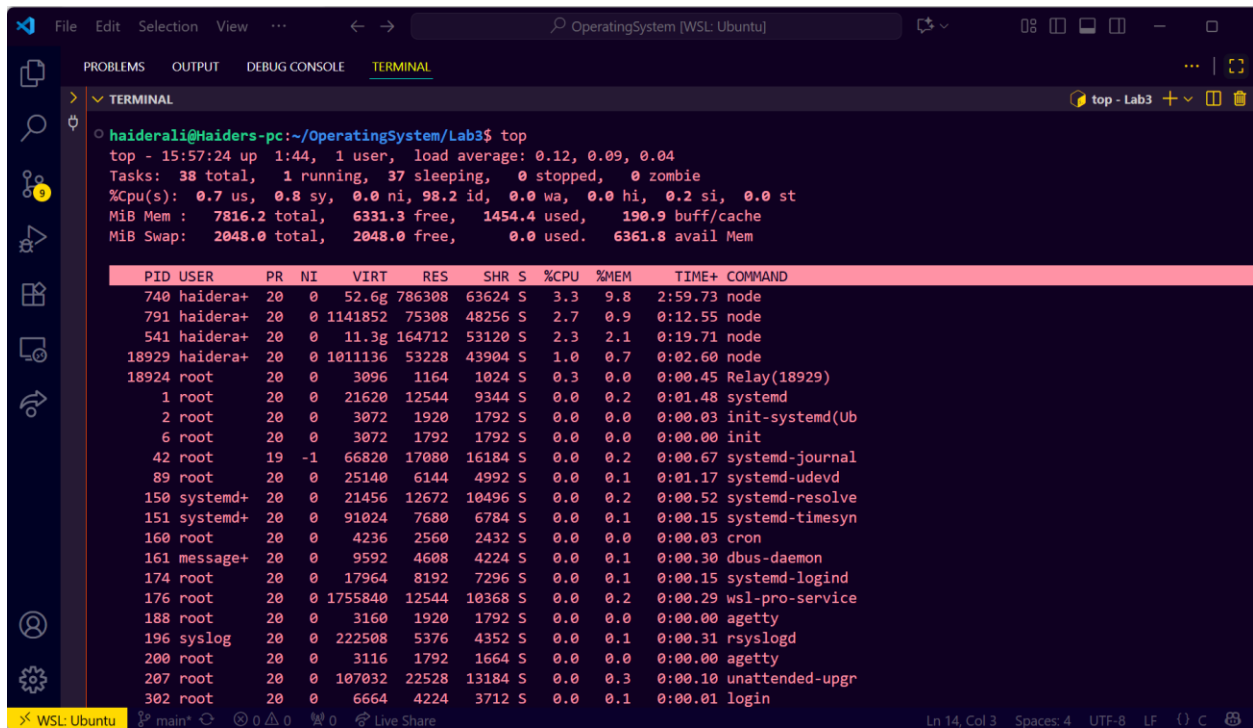
```
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ps -ef
UID          PID    PPID  C STIME TTY          TIME CMD
root         1        0  0 14:12 ?        00:00:01 /usr/lib/systemd/systemd --system --deserialize=58
root         2        1  0 14:12 ?        00:00:00 /init
root         6        2  0 14:12 ?        00:00:00 plan9 --control-socket 7 --log-level 4 --server-fd 8 --pipe-fd 10 --log-truncate
root        42        1  0 14:12 ?        00:00:00 /usr/lib/systemd/systemd-journald
root        89        1  0 14:12 ?        00:00:01 /usr/lib/systemd/systemd-udevd
systemd+    150       1  0 14:12 ?        00:00:00 /usr/lib/systemd/systemd-resolved
systemd+    151       1  0 14:12 ?        00:00:00 /usr/lib/systemd/systemd-timesyncd
root       160       1  0 14:12 ?        00:00:00 /usr/sbin/cron -f -P
message+   161       1  0 14:12 ?        00:00:00 @dbus-daemon --system --address=systemd: --nofork --nopidfile --systemd-activation
root       174       1  0 14:12 ?        00:00:00 /usr/lib/systemd/systemd-logind
root       176       1  0 14:12 ?        00:00:00 /usr/libexec/wsl-pro-service -vv
root       188       1  0 14:12 hvcs0    00:00:00 /sbin/agetty -o -p -- \u --noclear --keep-baud - 115200,38400,9600 vt220
syslog     196       1  0 14:12 ?        00:00:00 /usr/sbin/rsyslogd -n -iNONE
root       200       1  0 14:12 tty1     00:00:00 /sbin/agetty -o -p -- \u --noclear - linux
root       207       1  0 14:12 ?        00:00:00 /usr/bin/python3 /usr/share/unattended-upgrades/unattended-upgrade-shutdown --wait
root       302       2  0 14:12 pts/1   00:00:00 /bin/login -f
haidera+   346       1  0 14:12 ?        00:00:00 /usr/lib/systemd/systemd --user
haidera+   347      346  0 14:12 ?        00:00:00 (sd-pam)
haidera+   368      302  0 14:12 pts/1   00:00:00 -bash
root       424       2  0 14:12 ?        00:00:00 /init
root       425      424  0 14:12 ?        00:00:00 /init
haidera+   426      425  0 14:12 pts/0    00:00:00 sh -c "$VS_CODE_WSL_EXT_LOCATION/scripts/wslServer.sh" e3a5acfb517a443235981655413d
haidera+   428      426  0 14:12 pts/0    00:00:00 sh /mnt/c/Users/LENOVO/.vscode/extensions/ms-vscode-remote.remote-wsl-0.104.3/scri
haidera+   537      428  0 14:12 pts/0    00:00:00 sh /home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/bin
haidera+   541      537  0 14:12 pts/0    00:00:19 /home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/bin
haidera+   740      541  2 14:13 pts/0    00:02:56 /home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/node
haidera+   769      740  0 14:13 pts/0    00:00:00 /home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/node
```

ps -ef | grep bash:



```
haiderali@Haiderali-pc:~/OperatingSystem/Lab3$ ps -ef | grep haiderali
haidera+   537      428  0 14:12 pts/0    00:00:00 sh /home/haiderali/.vscode-server/bin/e3a5acfb517a4432359816
/code-server --host=127.0.0.1 --port=0 --connection-token=2886270863-1995598425-2345759319-3771431653 --use-host
er-env-var --disable-websocket-compression --accept-server-license-terms --telemetry-level=all
haidera+   541      537  0 14:12 pts/0    00:00:19 /home/haiderali/.vscode-server/bin/e3a5acfb517a4432359816554
home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/out/server-main.js --host=127.0.0.1 -
oken=2886270863-1995598425-2345759319-3771431653 --use-host-proxy --without-browser-env-var --disable-websocket-
erver-license-terms --telemetry-level=all
haidera+   740      541  2 14:13 pts/0    00:02:58 /home/haiderali/.vscode-server/bin/e3a5acfb517a4432359816554
-dns-result-order=ipv4first /home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/out/boot
nsionHost --transformURIs --useHostProxy=true
haidera+   769      740  0 14:13 pts/0    00:00:00 /home/haiderali/.vscode-server/bin/e3a5acfb517a4432359816554
home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/extensions/markdown-language-features
--node-ipc --clientProcessId=740
haidera+   777      541  0 14:13 pts/0    00:00:01 /home/haiderali/.vscode-server/bin/e3a5acfb517a4432359816554
home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/out/bootstrap-fork --type=fileWatcher
haidera+   791      541  0 14:13 pts/0    00:00:12 /home/haiderali/.vscode-server/bin/e3a5acfb517a4432359816554
home/haiderali/.vscode-server/bin/e3a5acfb517a443235981655413d566533107e92/out/bootstrap-fork --type=ptyHost --l
i/.vscode-server/data/logs/20251003T140733
haidera+   938      791  0 14:13 pts/6    00:00:00 /bin/bash --init-file /home/haiderali/.vscode-server/bin/e3a
13d566533107e92/out/vs/workbench/contrib/terminal/common/scripts/shellIntegration-bash.sh
haidera+  18929  18924  0 15:42 pts/2    00:00:02 /home/haiderali/.vscode-server/bin/e3a5acfb517a4432359816554
e const net = require('net'); process.stdin.pause(); const client = net.createConnection({ host: '127.0.0.1', po
lient.pipe(process.stdout); process.stdin.pipe(client); }); client.on('close', function (hadError) { console.err
close with error' : 'Remote close'); process.exit(hadError ? 1 : 0); }); client.on('error', function (err) { pro
&& (err.stack || err.message) || String(err)); });
haidera+  18941  18940  0 15:42 pts/3    00:00:02 /home/haiderali/.vscode-server/bin/e3a5acfb517a4432359816554
```

top → Dynamic process viewer:

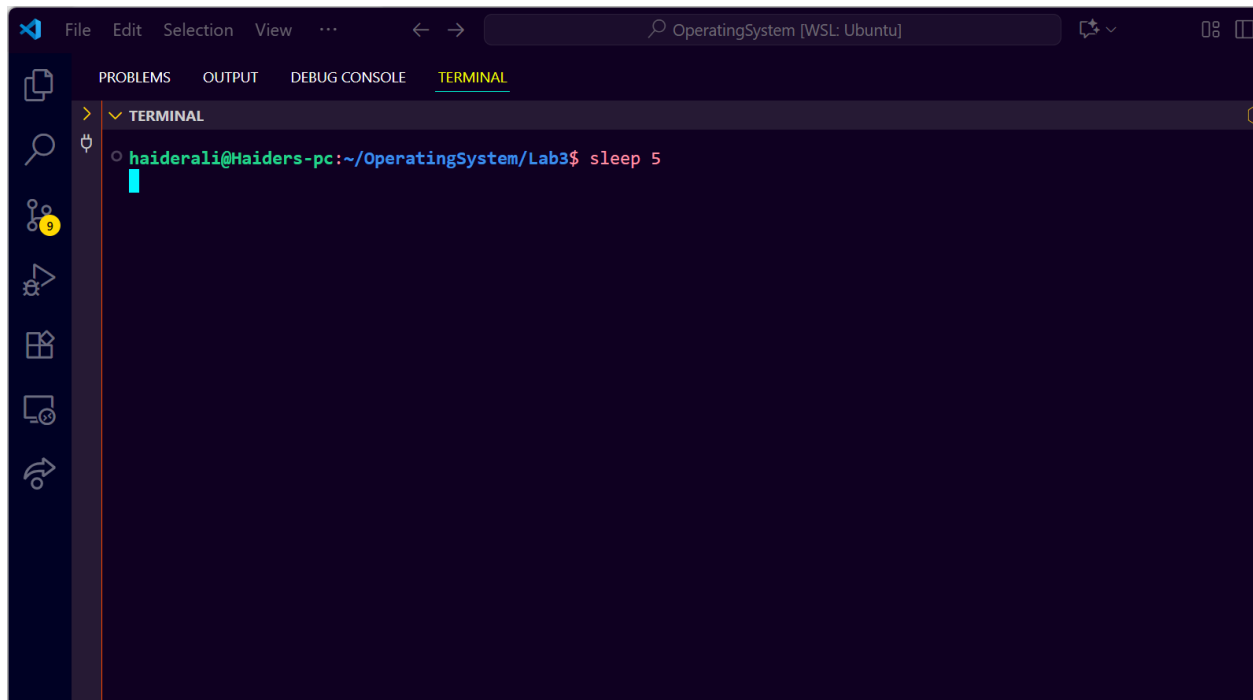


```
haiderali@Haider-PC:~/OperatingSystem/Lab3$ top
top - 15:57:24 up 1:44, 1 user, load average: 0.12, 0.09, 0.04
Tasks: 38 total, 1 running, 37 sleeping, 0 stopped, 0 zombie
%Cpu(s): 0.7 us, 0.8 sy, 0.0 ni, 98.2 id, 0.0 wa, 0.0 hi, 0.2 si, 0.0 st
MiB Mem : 7816.2 total, 6331.3 free, 1454.4 used, 190.9 buff/cache
MiB Swap: 2048.0 total, 2048.0 free, 0.0 used, 6361.8 avail Mem

  PID USER      PR  NI  VIRT  RES  SHR  S  %CPU  %MEM    TIME+  COMMAND
 740 haidera+  20   0   52.6g 786308 63624 S   3.3   9.8   2:59.73 node
 791 haidera+  20   0 1141852 75308 48256 S   2.7   0.9   0:12.55 node
 541 haidera+  20   0   11.3g 164712 53120 S   2.3   2.1   0:19.71 node
18929 haidera+  20   0 1011136 53228 43904 S   1.0   0.7   0:02.60 node
18924 root        20   0   3096   1164  1024 S   0.3   0.0   0:00.45 Relay(18929)
    1 root        20   0   21620  12544  9344 S   0.0   0.2   0:01.48 systemd
    2 root        20   0   3072   1920  1792 S   0.0   0.0   0:00.03 init-systemd(Ub
    6 root        20   0   3072   1792  1792 S   0.0   0.0   0:00.00 init
   42 root        19  -1   66820  17080  16184 S   0.0   0.2   0:00.67 systemd-journal
   89 root        20   0   25140   6144  4992 S   0.0   0.1   0:01.17 systemd-udev
  150 systemd+  20   0   21456  12672  10496 S   0.0   0.2   0:00.52 systemd-resolve
  151 systemd+  20   0   91024   7680  6784 S   0.0   0.1   0:00.15 systemd-timesyn
  160 root        20   0   4236   2560  2432 S   0.0   0.0   0:00.03 cron
  161 message+  20   0   9592   4608  4224 S   0.0   0.1   0:00.30 dbus-daemon
  174 root        20   0   17964   8192  7296 S   0.0   0.1   0:00.15 systemd-logind
  176 root        20   0 1755840 12544 10368 S   0.0   0.2   0:00.29 wsl-pro-service
  188 root        20   0   3160   1920  1792 S   0.0   0.0   0:00.00 agetty
  196 syslog     20   0 222508   5376  4352 S   0.0   0.1   0:00.31 rsyslogd
  200 root        20   0   3116   1792  1664 S   0.0   0.0   0:00.00 agetty
  207 root        20   0 107032 22528 13184 S   0.0   0.3   0:00.10 unattended-upgr
  302 root        20   0   6664   4224  3712 S   0.0   0.1   0:00.01 login
```

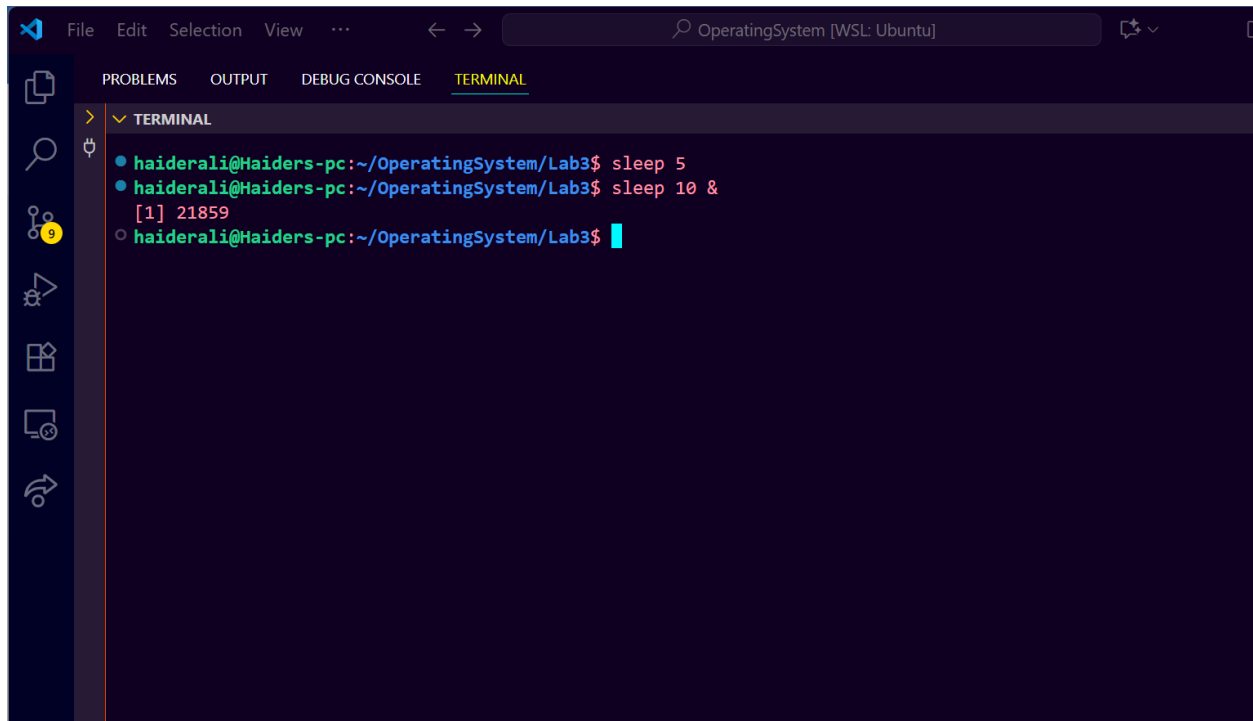
Foreground and Background Job:

Foreground:



```
haiderali@Haider-PC:~/OperatingSystem/Lab3$ sleep 5
```

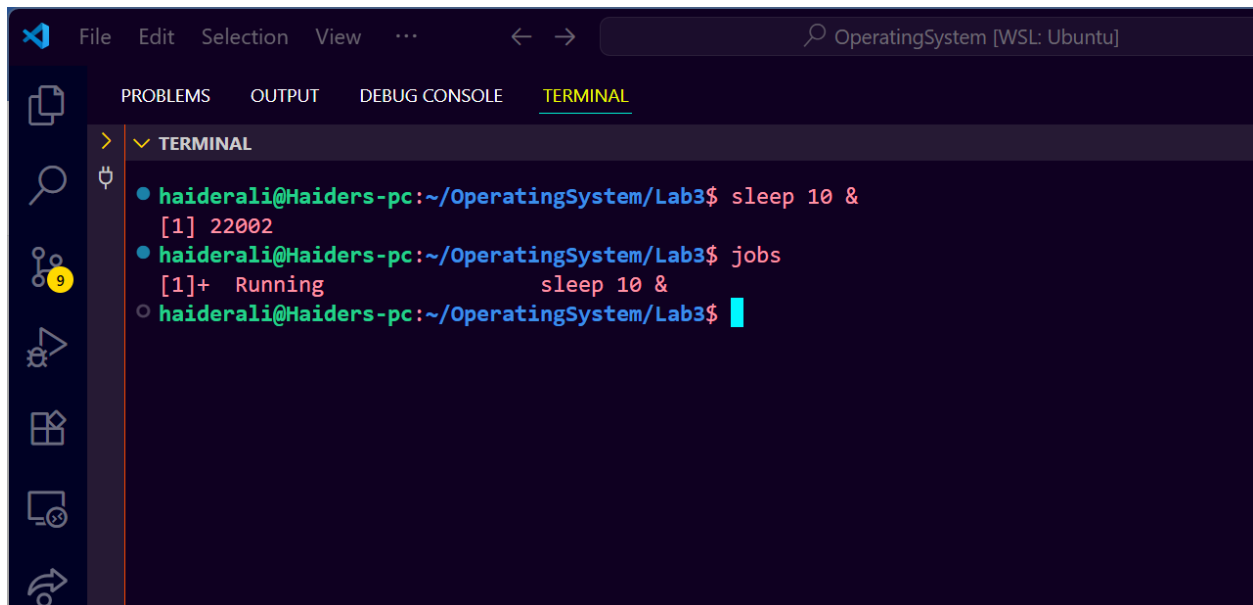
Background:



A screenshot of a Visual Studio Code terminal window titled "OperatingSystem [WSL: Ubuntu]". The terminal shows the following commands and output:

```
haiderali@Haiders-pc:~/OperatingSystem/Lab3$ sleep 5
haiderali@Haiderali@Haiders-pc:~/OperatingSystem/Lab3$ sleep 10 &
[1] 21859
haiderali@Haiderali@Haiders-pc:~/OperatingSystem/Lab3$
```

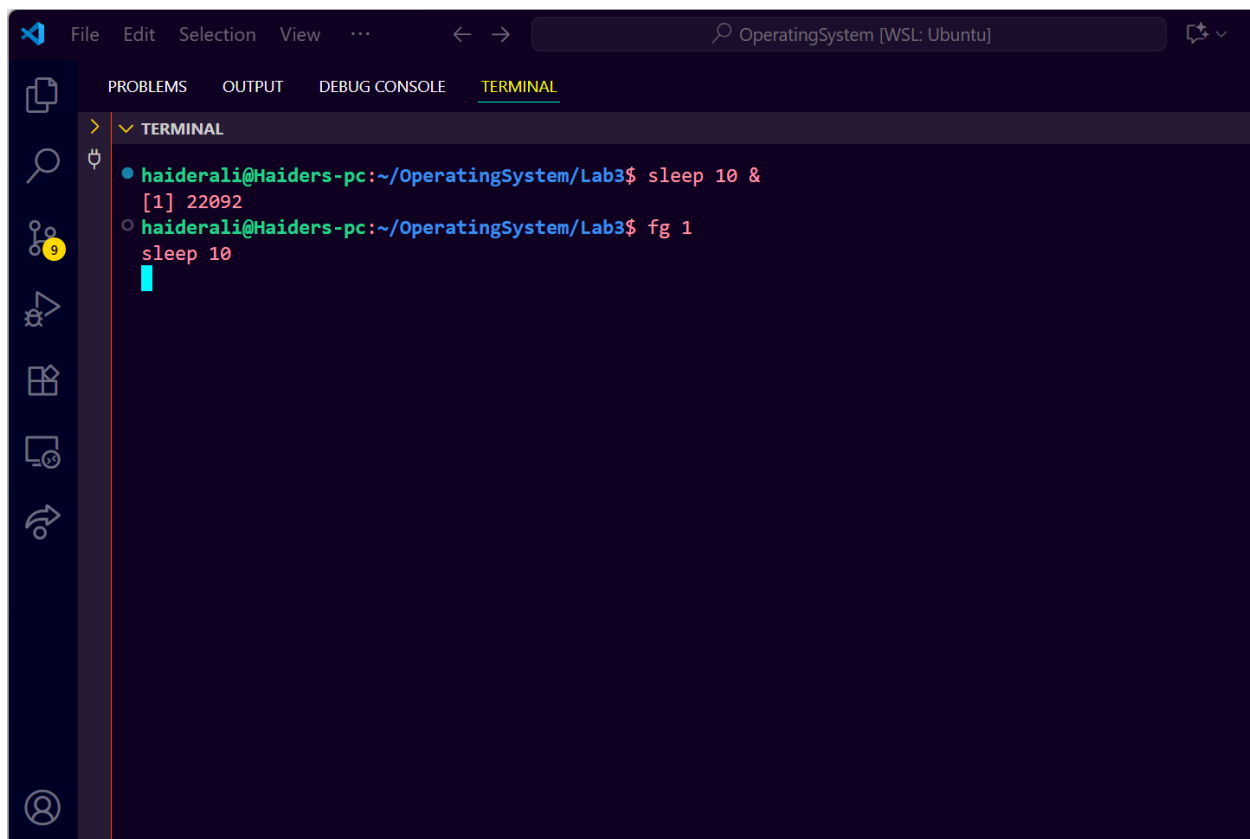
Check background jobs:



A screenshot of a Visual Studio Code terminal window titled "OperatingSystem [WSL: Ubuntu]". The terminal shows the following commands and output:

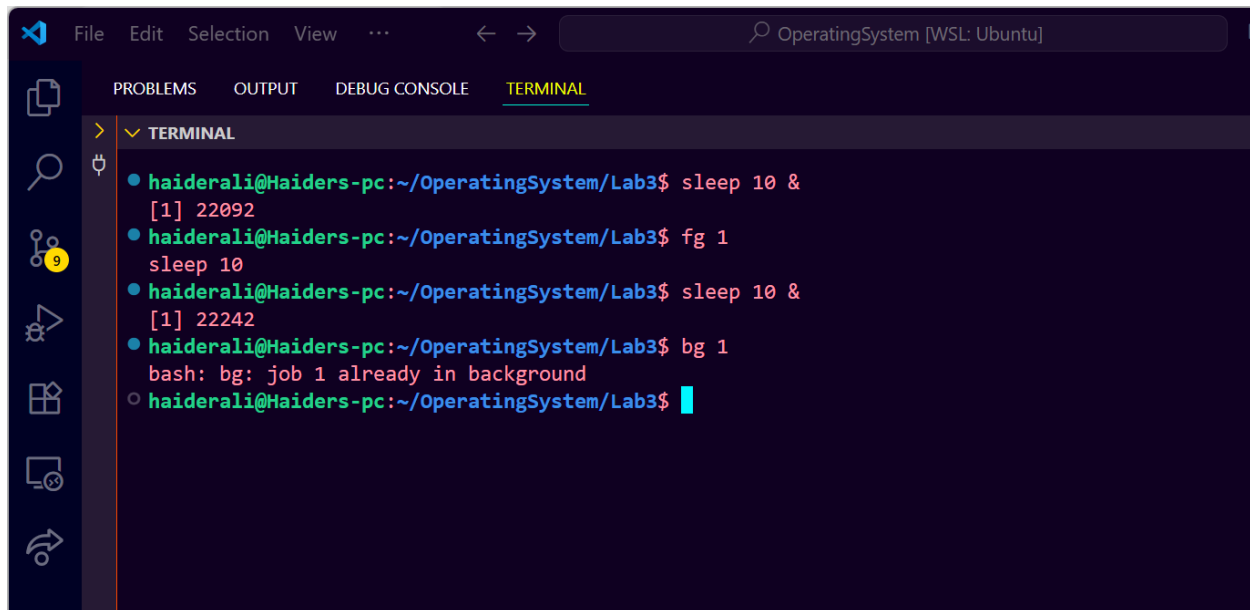
```
haiderali@Haiders-pc:~/OperatingSystem/Lab3$ sleep 10 &
[1] 22002
haiderali@Haiderali@Haiders-pc:~/OperatingSystem/Lab3$ jobs
[1]+  Running                  sleep 10 &
haiderali@Haiderali@Haiders-pc:~/OperatingSystem/Lab3$
```

Bring a job to foreground:



The screenshot shows a Visual Studio Code window with the 'OperatingSystem [WSL: Ubuntu]' workspace. The 'TERMINAL' tab is active, displaying the following commands and output:

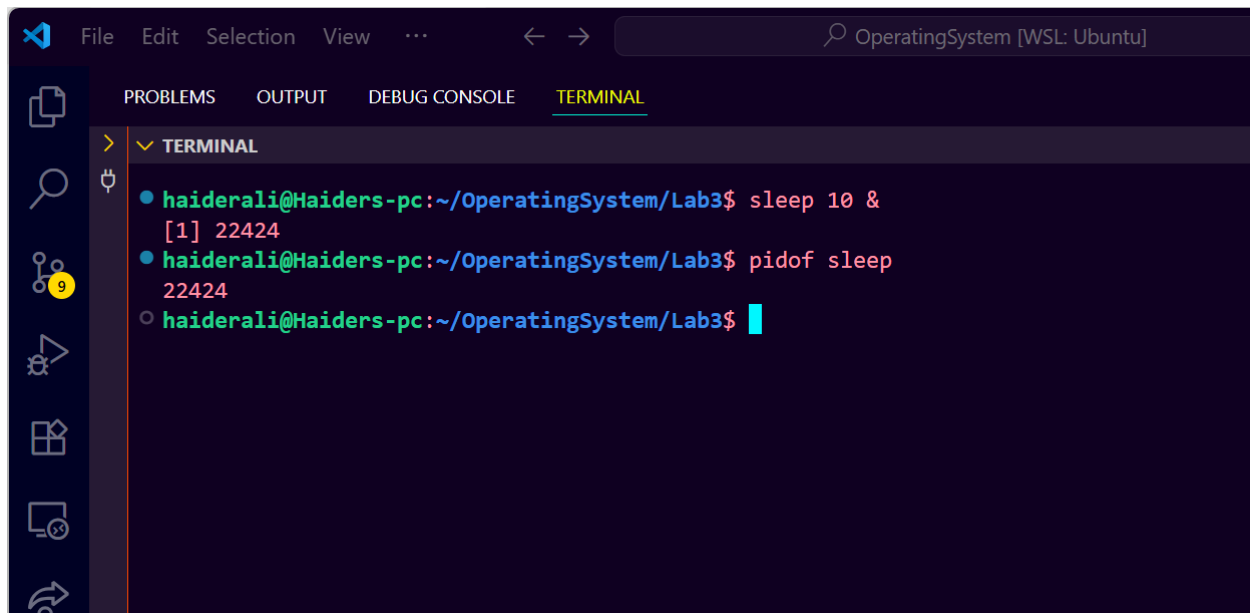
```
haiderali@Haider-pc:~/OperatingSystem/Lab3$ sleep 10 &
[1] 22092
haiderali@Haider-pc:~/OperatingSystem/Lab3$ fg 1
sleep 10
```



The screenshot shows a Visual Studio Code window with the 'OperatingSystem [WSL: Ubuntu]' workspace. The 'TERMINAL' tab is active, displaying the following commands and output:

```
haiderali@Haider-pc:~/OperatingSystem/Lab3$ sleep 10 &
[1] 22092
haiderali@Haider-pc:~/OperatingSystem/Lab3$ fg 1
sleep 10
haiderali@Haider-pc:~/OperatingSystem/Lab3$ sleep 10 &
[1] 22242
haiderali@Haider-pc:~/OperatingSystem/Lab3$ bg 1
bash: bg: job 1 already in background
haiderali@Haider-pc:~/OperatingSystem/Lab3$
```

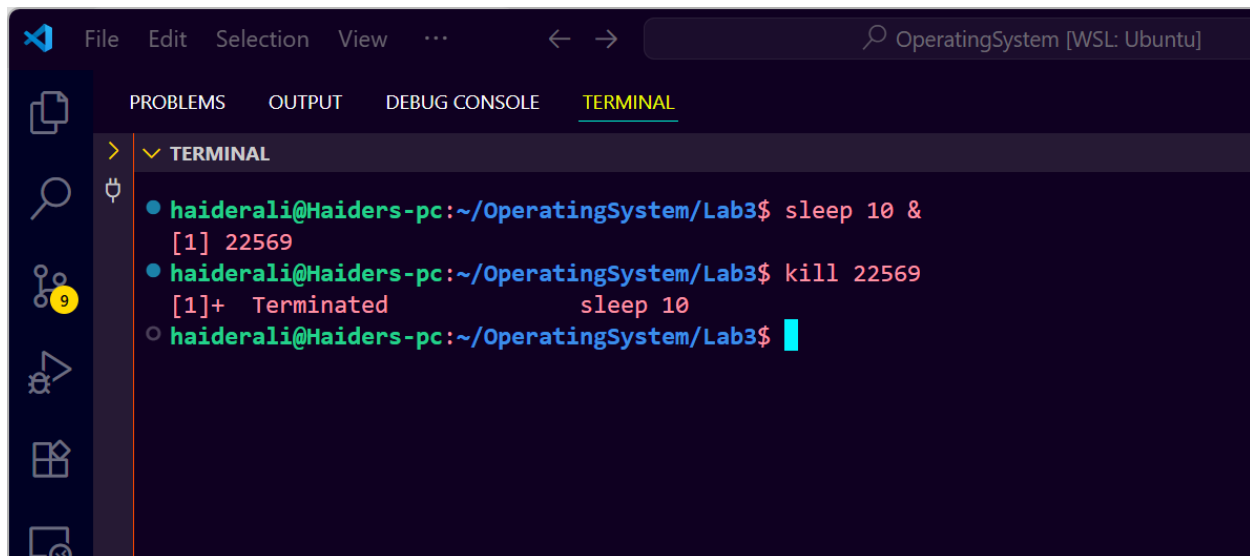
Process Identification:



The screenshot shows a VS Code window with the 'OperatingSystem [WSL: Ubuntu]' title. The 'TERMINAL' tab is active, displaying the following commands and output:

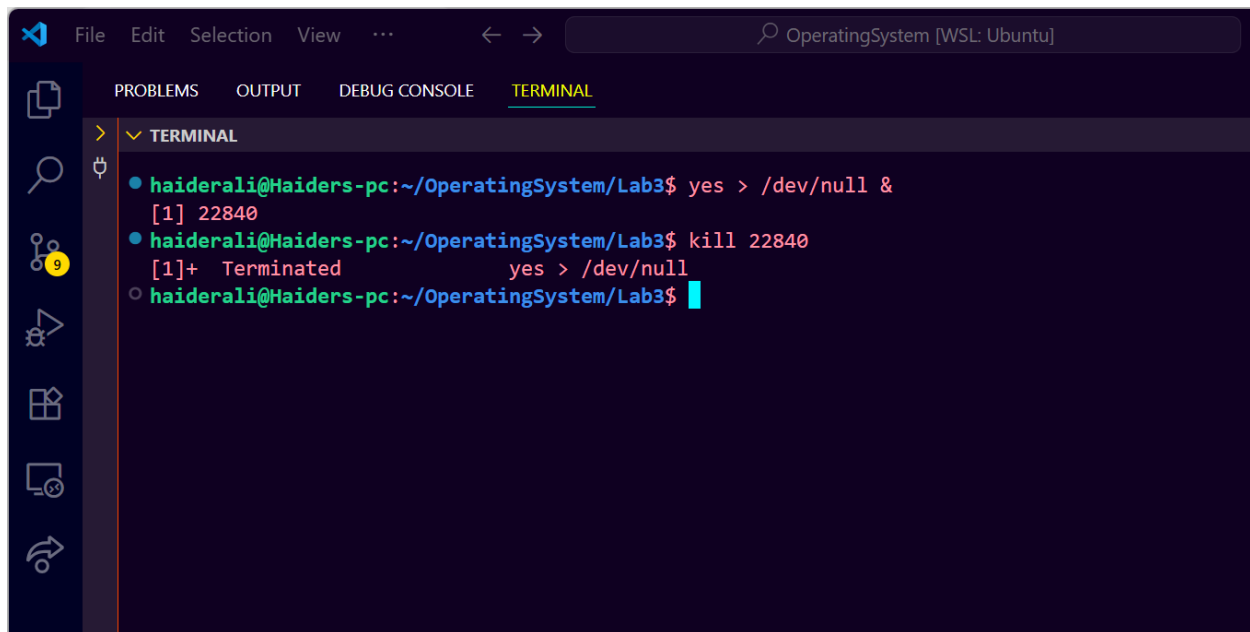
```
haiderali@Haiders-pc:~/OperatingSystem/Lab3$ sleep 10 &
[1] 22424
haiderali@Haiders-pc:~/OperatingSystem/Lab3$ pidof sleep
22424
haiderali@Haiders-pc:~/OperatingSystem/Lab3$
```

Killing Processes:



The screenshot shows a VS Code window with the 'OperatingSystem [WSL: Ubuntu]' title. The 'TERMINAL' tab is active, displaying the following commands and output:

```
haiderali@Haiders-pc:~/OperatingSystem/Lab3$ sleep 10 &
[1] 22569
haiderali@Haiders-pc:~/OperatingSystem/Lab3$ kill 22569
[1]+  Terminated                  sleep 10
haiderali@Haiders-pc:~/OperatingSystem/Lab3$
```



The image shows a Visual Studio Code window with a terminal open. The terminal title is "OperatingSystem [WSL: Ubuntu]". The terminal output shows a user named "haiderali@Haiders-pc" running a script in the directory "~/OperatingSystem/Lab3". The script consists of three lines: 1. "yes > /dev/null &" which starts a background process and returns PID 22840. 2. "kill 22840" which sends a signal to the process, resulting in "[1]+ Terminated yes > /dev/null". 3. A blank line where the prompt returns.

```
haiderali@Haiders-pc:~/OperatingSystem/Lab3$ yes > /dev/null &
[1] 22840
haiderali@Haiders-pc:~/OperatingSystem/Lab3$ kill 22840
[1]+  Terminated                  yes > /dev/null
haiderali@Haiders-pc:~/OperatingSystem/Lab3$
```