# Assignment 4 - Process Management & Signal Handling

### Part 1: Process Exploration

1. List all running processes using:
    - `ps -ef`
    - `ps aux`

ubuntu@ip-172-31-16-28: ~

```
ubuntu@ip-172-31-16-28:~$ ps -ef
UID          PID    PPID  C STIME TTY          TIME CMD
root           1       0  0 18:04 ?        00:00:01 /sbin/init
root           2       0  0 18:04 ?        00:00:00 [kthreadd]
root           3       2  0 18:04 ?        00:00:00 [pool_workqueue_release]
root           4       2  0 18:04 ?        00:00:00 [kworker/R-rcu_gp]
root           5       2  0 18:04 ?        00:00:00 [kworker/R-sync_wq]
root           6       2  0 18:04 ?        00:00:00 [kworker/R-kvfree_rcu_reclaim]
root           7       2  0 18:04 ?        00:00:00 [kworker/R-slub_flushwq]
root           8       2  0 18:04 ?        00:00:00 [kworker/R-netns]
root          11       2  0 18:04 ?        00:00:00 [kworker/0:0H-events_highpri]
root          12       2  0 18:04 ?        00:00:00 [kworker/u8:0-events_power_efficient]
root          13       2  0 18:04 ?        00:00:00 [kworker/R-mm_percpu_wq]
root          14       2  0 18:04 ?        00:00:00 [rcu_tasks_rude_kthread]
root          15       2  0 18:04 ?        00:00:00 [rcu_tasks_trace_kthread]
root          16       2  0 18:04 ?        00:00:00 [ksoftirqd/0]
root          17       2  0 18:04 ?        00:00:00 [rcu_sched]
root          18       2  0 18:04 ?        00:00:00 [rcu_exp_par_gp_kthread_worker/0]
root          19       2  0 18:04 ?        00:00:00 [rcu_exp_gp_kthread_worker]
root          20       2  0 18:04 ?        00:00:00 [migration/0]
root          21       2  0 18:04 ?        00:00:00 [idle_inject/0]
root          22       2  0 18:04 ?        00:00:00 [cpuhp/0]
root          23       2  0 18:04 ?        00:00:00 [cpuhp/1]
root          24       2  0 18:04 ?        00:00:00 [idle_inject/1]
root          25       2  0 18:04 ?        00:00:00 [migration/1]
root          26       2  0 18:04 ?        00:00:00 [ksoftirqd/1]
root          27       2  0 18:04 ?        00:00:00 [kworker/1:0-events]
root          28       2  0 18:04 ?        00:00:00 [kworker/1:0H-events_highpri]
root          29       2  0 18:04 ?        00:00:00 [kdevtmpfs]
root          30       2  0 18:04 ?        00:00:00 [kworker/R-inet_frag_wq]
root          31       2  0 18:04 ?        00:00:00 [kauditd]
root          32       2  0 18:04 ?        00:00:00 [khungtaskd]
root          34       2  0 18:04 ?        00:00:00 [oom_reaper]
root          35       2  0 18:04 ?        00:00:00 [kworker/u8:2-events_unbound]
root          36       2  0 18:04 ?        00:00:00 [kworker/R-writeback]
root          37       2  0 18:04 ?        00:00:00 [kcompactd0]
root          38       2  0 18:04 ?        00:00:00 [ksmd]
root          39       2  0 18:04 ?        00:00:00 [khugepaged]
root          40       2  0 18:04 ?        00:00:00 [kworker/R-kintegrityd]
root          41       2  0 18:04 ?        00:00:00 [kworker/R-kblockd]
root          42       2  0 18:04 ?        00:00:00 [kworker/R-blkcg_punt_bio]
root          43       2  0 18:04 ?        00:00:00 [irq/9-acpi]
root          45       2  0 18:04 ?        00:00:00 [kworker/R-tpm_dev_wq]
root          46       2  0 18:04 ?        00:00:00 [kworker/R-ata_sff]
```

```
ubuntu@ip-172-31-16-28:~$ ps aux
USER         PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root           1  0.0  1.4  22644 13932 ?        Ss   18:04   0:01 /sbin/init
root           2  0.0  0.0      0     0 ?        S    18:04   0:00 [kthreadd]
root           3  0.0  0.0      0     0 ?        S    18:04   0:00 [pool_workqueue_release]
root           4  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-rcu_gp]
root           5  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-sync_wq]
root           6  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-kvfree_rcu_reclaim]
root           7  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-slub_flushwq]
root           8  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-netns]
root          11  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/0:0H-events_highpri]
root          12  0.0  0.0      0     0 ?        I    18:04   0:00 [kworker/u8:0-events_power_efficient]
root          13  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-mm_percpu_wq]
root          14  0.0  0.0      0     0 ?        I    18:04   0:00 [rcu_tasks_rude_kthread]
root          15  0.0  0.0      0     0 ?        I    18:04   0:00 [rcu_tasks_trace_kthread]
root          16  0.0  0.0      0     0 ?        S    18:04   0:00 [ksoftirqd/0]
root          17  0.0  0.0      0     0 ?        I    18:04   0:00 [rcu_sched]
root          18  0.0  0.0      0     0 ?        S    18:04   0:00 [rcu_exp_par_gp_kthread_worker/0]
root          19  0.0  0.0      0     0 ?        S    18:04   0:00 [rcu_exp_gp_kthread_worker]
root          20  0.0  0.0      0     0 ?        S    18:04   0:00 [migration/0]
root          21  0.0  0.0      0     0 ?        S    18:04   0:00 [idle_inject/0]
root          22  0.0  0.0      0     0 ?        S    18:04   0:00 [cpuhp/0]
root          23  0.0  0.0      0     0 ?        S    18:04   0:00 [cpuhp/1]
root          24  0.0  0.0      0     0 ?        S    18:04   0:00 [idle_inject/1]
root          25  0.0  0.0      0     0 ?        S    18:04   0:00 [migration/1]
root          26  0.0  0.0      0     0 ?        S    18:04   0:00 [ksoftirqd/1]
root          27  0.0  0.0      0     0 ?        I    18:04   0:00 [kworker/1:0-events]
root          28  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/1:0H-events_highpri]
root          29  0.0  0.0      0     0 ?        S    18:04   0:00 [kdevtmpfs]
root          30  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-inet_frag_wq]
root          31  0.0  0.0      0     0 ?        S    18:04   0:00 [kauditd]
root          32  0.0  0.0      0     0 ?        S    18:04   0:00 [khungtaskd]
root          34  0.0  0.0      0     0 ?        S    18:04   0:00 [oom_reaper]
root          35  0.0  0.0      0     0 ?        I    18:04   0:00 [kworker/u8:2-events_power_efficient]
root          36  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-writeback]
root          37  0.0  0.0      0     0 ?        S    18:04   0:00 [kcompactd0]
root          38  0.0  0.0      0     0 ?        SN   18:04   0:00 [ksmd]
root          39  0.0  0.0      0     0 ?        SN   18:04   0:00 [khugepaged]
root          40  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-kintegrityd]
root          41  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-kblockd]
root          42  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-blkcg_punt_bio]
root          43  0.0  0.0      0     0 ?        S    18:04   0:00 [irq/9-acpi]
root          45  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-tpm_dev_wq]
root          46  0.0  0.0      0     0 ?        I<   18:04   0:00 [kworker/R-ata_sff]
```

### Part 2: Background Jobs

1. Start a long-running command: sleep 1000 &

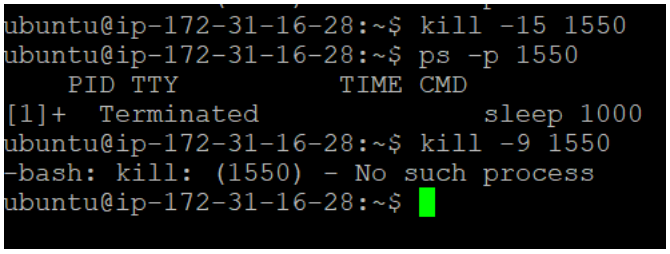
2. View running background jobs.

3. Bring the job to foreground and send it back to background.

```
ubuntu@ip-172-31-16-28:~$ sleep 1000 &
[1] 1550
ubuntu@ip-172-31-16-28:~$ jobs
[1]+  Running                 sleep 1000 &
ubuntu@ip-172-31-16-28:~$ fg %1
sleep 1000
^Z
[1]+  Stopped                 sleep 1000
ubuntu@ip-172-31-16-28:~$ bg %1
[1]+ sleep 1000 &
ubuntu@ip-172-31-16-28:~$ jobs
[1]+  Running                 sleep 1000 &
ubuntu@ip-172-31-16-28:~$
```

## Part 3: Process Termination & Signals

1. Gracefully stop the `sleep` process using:
    - `SIGTERM`
2. Verify if the process still exists.
3. Forcefully terminate it using:
    - `SIGKILL`
4. Explain the difference between:
    - `kill -15`
    - `kill -9`




kill 9 - terminates the process rightaway ( force kill or immediate kill)

kill15 – graceful termination, terminates and allows to save data till what work is done.

## Part 4: Real-Time Monitoring

1. Use `top` to:
    - Identify top CPU-consuming processes
    - Sort by memory usage
2. Observe changes in real time.

```
ubuntu@ip-172-31-16-28:~$ top
top - 18:44:58 up 40 min,  1 user,  load average: 0.04, 0.01, 0.00
Tasks: 110 total,   1 running, 109 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.0 us,  4.5 sy,  0.0 ni, 95.5 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :    914.2 total,     71.5 free,    705.1 used,    295.0 buff/cache
MiB Swap:      0.0 total,      0.0 free,      0.0 used.    209.1 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
      1 root      20   0   22644  13932   9636 S   0.0   1.5   0:01.64 systemd
      2 root      20   0       0      0      0 S   0.0   0.0   0:00.00 kthreadd
      3 root      20   0       0      0      0 S   0.0   0.0   0:00.00 pool_workqueue_release
      4 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/R-rcu_gp
      5 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/R-sync_wq
      6 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/R-kvfree_rcu_reclaim
      7 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/R-slub_flushwq
      8 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/R-netns
     11 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/0:0H-events_highpri
     12 root      20   0       0      0      0 I   0.0   0.0   0:00.17 kworker/u8:0-events_power_efficient
     13 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/R-mm_percpu_wq
     14 root      20   0       0      0      0 I   0.0   0.0   0:00.00 rcu_tasks_rude_kthread
     15 root      20   0       0      0      0 I   0.0   0.0   0:00.00 rcu_tasks_trace_kthread
     16 root      20   0       0      0      0 S   0.0   0.0   0:00.03 ksoftirqd/0
     17 root      20   0       0      0      0 I   0.0   0.0   0:00.13 rcu_sched
     18 root      20   0       0      0      0 S   0.0   0.0   0:00.00 rcu_exp_par_gp_kthread_worker/0
     19 root      20   0       0      0      0 S   0.0   0.0   0:00.00 rcu_exp_gp_kthread_worker
     20 root      rt   0       0      0      0 S   0.0   0.0   0:00.01 migration/0
     21 root     -51   0       0      0      0 S   0.0   0.0   0:00.00 idle_inject/0
     22 root      20   0       0      0      0 S   0.0   0.0   0:00.00 cpuhp/0
     23 root      20   0       0      0      0 S   0.0   0.0   0:00.00 cpuhp/1
     24 root     -51   0       0      0      0 S   0.0   0.0   0:00.00 idle_inject/1
     25 root      rt   0       0      0      0 S   0.0   0.0   0:00.07 migration/1
     26 root      20   0       0      0      0 S   0.0   0.0   0:00.02 ksoftirqd/1
     27 root      20   0       0      0      0 I   0.0   0.0   0:00.25 kworker/1:0-events
     28 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/1:0H-events_highpri
     29 root      20   0       0      0      0 S   0.0   0.0   0:00.00 kdevtmpfs
     30 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/R-inet_frag_wq
     31 root      20   0       0      0      0 S   0.0   0.0   0:00.00 kauditd
     32 root      20   0       0      0      0 S   0.0   0.0   0:00.00 khungtaskd
     34 root      20   0       0      0      0 S   0.0   0.0   0:00.00 oom_reaper
     35 root      20   0       0      0      0 I   0.0   0.0   0:00.09 kworker/u8:2-events_power_efficient
     36 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/R-writeback
     37 root      20   0       0      0      0 S   0.0   0.0   0:00.06 kcompactd0
     38 root      25   5       0      0      0 S   0.0   0.0   0:00.00 ksmd
     39 root      39  19       0      0      0 S   0.0   0.0   0:00.00 khugepaged
```