

# Operating System

## Practical-3

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**Aim:** Process Creation and Termination (Use of fork, wait, getpid, and getppid system calls).

### Theory:

#### Fork System Call:

```
#include <unistd.h>
```

```
pid_t fork(void);
```

**fork()** creates a new process by duplicating the calling process. The new process, referred to as the *child*, is an exact duplicate of the calling process, referred to as the *parent*, except for the following points:

- The child has its own unique process ID, and this PID does not match the ID of any existing process group.
- The child's parent process ID is the same as the parent's process ID.

On success, the PID of the child process is returned in the parent, and 0 is returned in the child.

On failure, -1 is returned in the parent, no child process is created, and *errno* is set appropriately.

#### Zombie Process:

A process which has finished the execution but still has entry in the process table to report to its parent process is known as a zombie process.

A child process always first becomes a zombie before being removed from the process table. The parent process reads the exit status of the child process which reaps off the child process entry from the process table.

#### Orphan Process:

A process whose parent process no more exists i.e. either finished or terminated without waiting for its child process to terminate is called an orphan process.

#### Getpid and Getppid System Calls:

```
#include<sys/types.h>  
#include <unistd.h>
```

```
pid_t getpid(void);  
pid_t getppid(void);
```

**getpid()** returns the process ID of the calling process.

**getppid()** returns the process ID of the parent of the calling process.

### **Wait System Call:**

```
#include<sys/types.h>  
#include <sys/wait.h>
```

```
pid_t wait(int *status);
```

wait system call is used to wait for state changes in a child of the calling process, and obtain information about the child whose state has changed.

A state change is considered to be: the child terminated; the child was stopped by a signal; or the child was resumed by a signal.

In the case of a terminated child, performing a wait allows the system to release the resources associated with the child; if a wait is not performed, then the terminated child remains in a "zombie" state.

If a child has already changed state, then this call returns immediately. Otherwise it blocks until either a child changes state or a signal handler interrupts the call.

On success, returns the process ID of the terminated child; on error, -1 is returned.

## Tasks

### Task 1:

Call fork once, twice, thrice and print “Hello”. Observe and interpret the outcomes.

#### Subtask 1: Calling fork once

```
#include<stdio.h>
#include<sys/types.h>
#include<unistd.h>

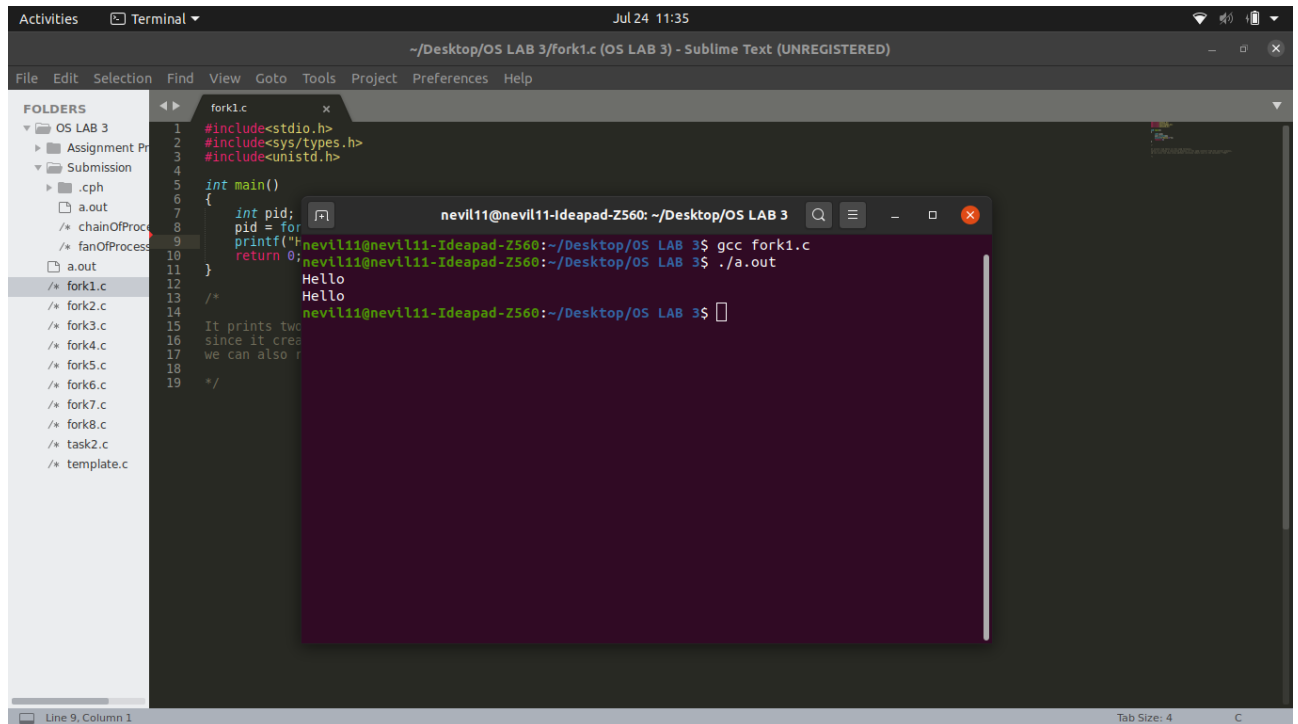
int main()
{
    int pid;
    pid = fork();
    printf("Hello\n");
    return 0;
}
```

/\*

*It prints two hello on the same terminal.  
since it creates a new child process of the same context from the parent process.  
we can also run this prog without catching return pid in the variable \*\*PID\*\**

\*/

## Output:



The screenshot shows a Sublime Text editor window titled "fork1.c" with the following code:

```
1 #include<stdio.h>
2 #include<sys/types.h>
3 #include<unistd.h>
4
5 int main()
6 {
7     int pid;
8     pid = fork();
9     printf("Hello\n");
10    return 0;
11 }
12
13 /*
14  * It prints two
15  * Hello
16  * since it creates two processes
17  * we can also run it multiple times
18  */
19
```

Below the editor, a terminal window titled "nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3" shows the execution of the program:

```
nevil11@nevil11-Ideapad-Z560:~/Desktop/OS LAB 3$ gcc fork1.c
nevil11@nevil11-Ideapad-Z560:~/Desktop/OS LAB 3$ ./a.out
Hello
Hello
nevil11@nevil11-Ideapad-Z560:~/Desktop/OS LAB 3$
```

## Subtask 2: Calling fork twice

```
#include<stdio.h>
#include<sys/types.h>
#include<unistd.h>

int main()
{
    int pid;
    pid = fork();
    pid = fork();
    printf("Hello\n");
    return 0;
}

/*
```

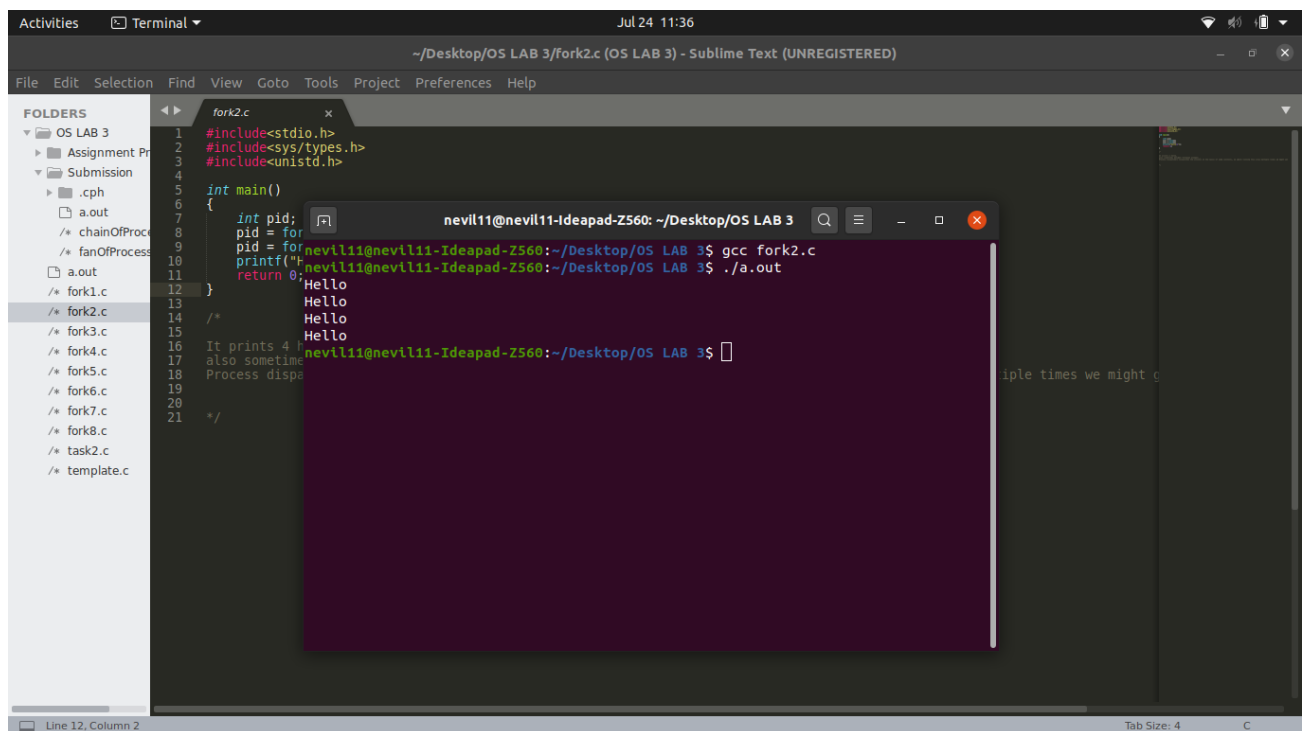
It prints 4 hello.

also sometimes between terminal prompts .

Process dispatchers dispatches the process on the basis of some contexts, so while running this prog multiple times we might get this kindof behaviour.

```
*/
```

### **Output:**

A screenshot of a Sublime Text editor window titled "fork2.c (OS LAB 3) - Sublime Text (UNREGISTERED)". The editor shows a C program with the following code:

```
1 #include<stdio.h>
2 #include<sys/types.h>
3 #include<unistd.h>
4
5
6
7 int main()
8 {
9     int pid;
10    pid = fork();
11    if (pid == 0)
12    {
13        printf("Hello\n");
14    }
15    /*
16     * It prints 4
17     * also sometime
18     * Process dispa
19     */
20
21    return 0;
22 }
```

The left sidebar shows a file explorer with folders "OS LAB 3", "Assignment Pr", "Submission", and ".cph", and files "a.out", "chainOfProc", "fanOfProcess", "fork1.c", "fork2.c", "fork3.c", "fork4.c", "fork5.c", "fork6.c", "fork7.c", "fork8.c", "task2.c", and "template.c". A terminal window is open in the foreground, showing the command "gcc fork2.c" and the output "Hello\nHello\nHello\nHello\n". The terminal prompt is "nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3\$".

### **Subtask 3: Calling fork thrice**

```
#include<stdio.h>
#include<sys/types.h>
#include<unistd.h>

int main()
{
    int pid;
    // printf("World");
    pid = fork();
```

```

    pid = fork();
    pid = fork();
    printf("Hello\n");
    return 0;
}

/*

```

It prints 8 hello.

after 1st fork there are 2 process . IP will point to second fork

each of newly created 2 processes points to third process. and same for the third fork, but this processes will point to printf.

So in total 8 processes will print :hello: 8 times.

Extra:

if we uncomment printf world line. Then the output is unpredictable. It will not flush the memory buffer and the word world will stay there.

```

*/

```

## Output:

The screenshot shows a Sublime Text editor with a file named `fork3.c` open. The code in the editor is as follows:

```

1 #include<stdio.h>
2 #include<sys/types.h>
3 #include<unistd.h>
4
5 int main()
6 {
7     // printf
8     pid = fork();
9     pid = fork();
10    printf("Hello\n");
11    return 0;
12 }
13
14 /*
15  It prints 8
16  after 1st fork
17  each of newl
18  and same for
19  So in total 8
20
21 Extra:
22 if we uncomm
23
24 */

```

The terminal output shows the following:

```

nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3
nevil11@nevil11-Ideapad-Z560:~/Desktop/OS LAB 3$ gcc fork3.c
nevil11@nevil11-Ideapad-Z560:~/Desktop/OS LAB 3$ ./a.out
Hello
Hello
Hello
Hello
Hello
Hello
Hello
Hello

```

## **Task 2:**

Print PID and PPID for parent and child processes. Observe and interpret the outcomes.

```
#include<stdio.h>
#include<sys/types.h>
#include<unistd.h>
// #include<sys/wait.h>

int main()
{
    int pid;
    // int status;
    pid = fork();
    if(pid == -1)
    {
        printf("Error!\n");
    }
    else if(pid > 0)
    {
        // wait(&status);
        printf("Hello from parent\n");
        printf("pid = %d\n",getpid());
        printf("ppid = %d\n",getppid());

    }
    else
    {
        // child part
        // pid = 0
        printf("Hello from child\n");
        printf("child pid = %d\n",getpid());
        printf("child ppid = %d\n",getppid());

    }
    return 0;
}
```

```
/*
```

Output:

```
Hello from parent
Hello from child
```

Extra:

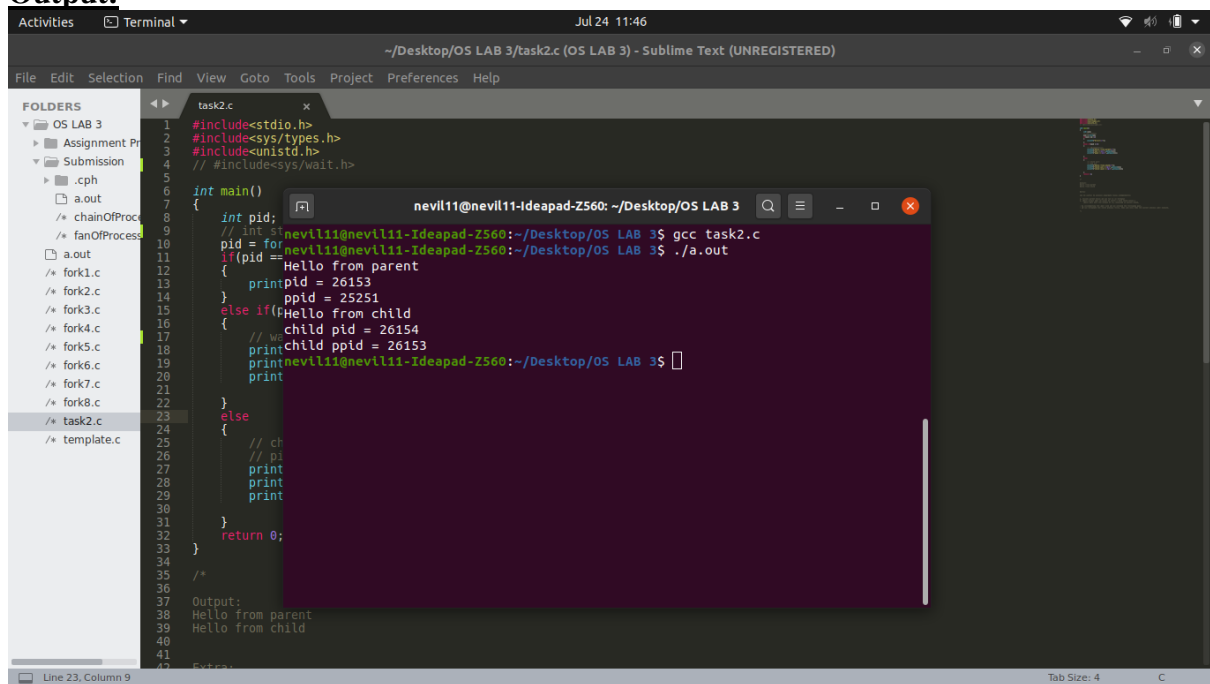
can be useful to achieve separate tasks independently

1. Inside parent block we can run `ls` in terminal
2. whose output will be given to child ( here child block ) which will sort the output of `ls`, executed in parent block.

- By uncommenting the `wait` line we can achieve the following goal.
- we can terminate the child process first, then and only then the parent process will execute.

```
*/
```

Output:



```
nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3
nevil11@nevil11-Ideapad-Z560:~/Desktop/OS LAB 3$ gcc task2.c
nevil11@nevil11-Ideapad-Z560:~/Desktop/OS LAB 3$ ./a.out
Hello from parent
Hello from child
```



### **Task 3:**

Add wait to the code of task 2. Observe and interpret the outcomes.

```
#include<stdio.h>
#include<unistd.h>
#include<sys/types.h>
#include<sys/wait.h>

int main()
{
    int pid;
    int status;
    pid = fork();
    if(pid == -1)
    {
        printf("Error!\n");
    }
    else if(pid > 0)
    {
        wait(&status);
        printf("Hello from parent\n");
        printf("pid = %d\n",getpid());
        printf("ppid = %d\n",getppid());
    }
    else
    {
        // child part
        // pid = 0
        printf("Hello from child\n");
        printf("child pid = %d\n",getpid());
        printf("child ppid = %d\n",getppid());
    }
    return 0;
}

/*
```

Output:

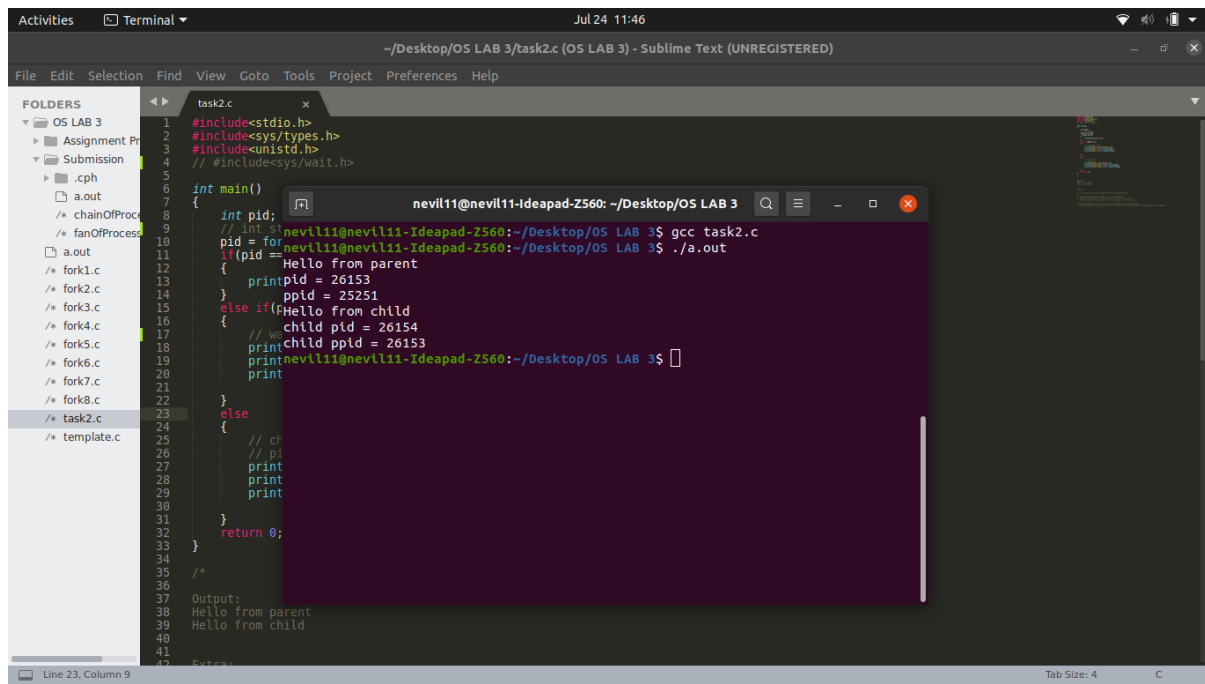
Hello from child  
Hello from parent

Exaplanation:

Here we are terminating the child process first, and then we will execute parent process.

\*/

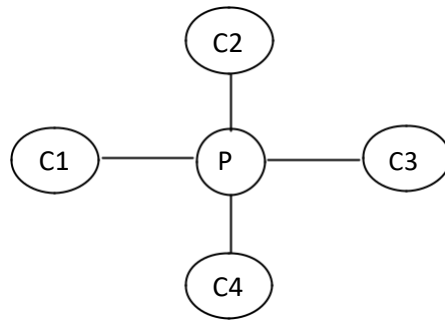
## Output:



The screenshot shows a Sublime Text editor window titled "task2.c" with the following code:

```
1 #include<stdio.h>
2 #include<sys/types.h>
3 #include<unistd.h>
4 // #include<sys/wait.h>
5
6 int main()
7 {
8     int pid;
9     // int s;
10    pid = fork();
11    if(pid == 0)
12    {
13        printf("Hello from parent\n");
14        pid = 25251;
15    }
16    else if(pid != 0)
17    {
18        printf("Hello from child\n");
19        pid = 26154;
20        printf("child pid = 26153\n");
21        printf("nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3\n");
22        printf("nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3\n");
23    }
24    else
25    {
26        // ch
27        // pi
28        printf("Hello from parent\n");
29        printf("Hello from child\n");
30    }
31    return 0;
32 }
33
34 /*
35
36
37 Output:
38 Hello from parent
39 Hello from child
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42 Extra:
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```

**Task 4:** Write a program to implement fan of n processes.

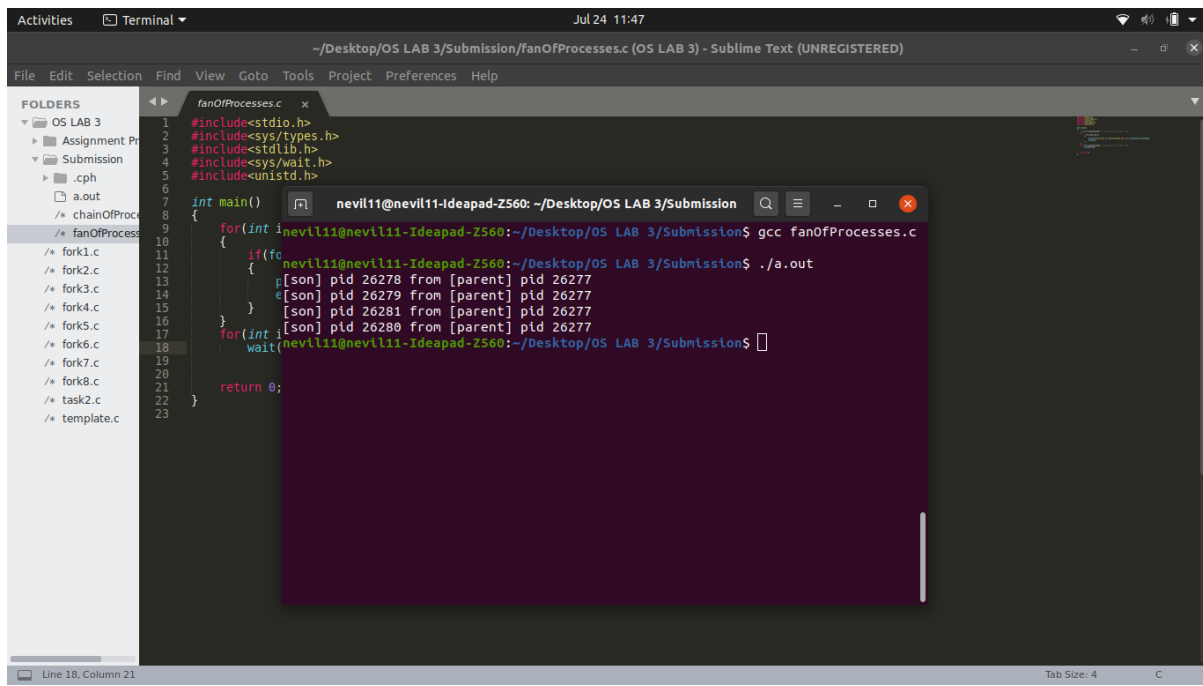


```
#include<stdio.h>
#include<sys/types.h>
#include<stdlib.h>
#include<sys/wait.h>
#include<unistd.h>

int main()
{
    for(int i=0;i<4;i++) // loop will run n times (n=4)
    {
        if(fork() == 0)
        {
            printf("[son] pid %d from [parent] pid %d\n",get
pid(),getppid());
            exit(0);
        }
    }
    for(int i=0;i<4;i++) // loop will run n times (n=4)
        wait(NULL);

    return 0;
}
```

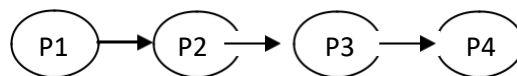
## Output:



```
1 #include<stdio.h>
2 #include<sys/types.h>
3 #include<stdlib.h>
4 #include<sys/wait.h>
5 #include<unistd.h>
6
7 int main()
8 {
9     for(int i=0; i<4; i++)
10     {
11         if(fork() < 0)
12             return 1;
13         if(i==0)
14             printf("I am a %s. My pid is:%d my ppid is %d\n", "parent", getpid(), getppid());
15         else
16             printf("I am a %s. My pid is:%d my ppid is %d\n", "child", getpid(), getppid());
17     }
18     return 0;
19 }
```

```
nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3/Submission$ gcc fanOfProcesses.c
nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3/Submission$ ./a.out
I am a parent. My pid is:26277 my ppid is 0
I am a child. My pid is:26278 my ppid is 26277
I am a child. My pid is:26279 my ppid is 26277
I am a child. My pid is:26281 my ppid is 26277
I am a child. My pid is:26280 my ppid is 26277
```

**Task 5:** Write a program to implement chain of n processes.



```
#include <sys/types.h>
#include <unistd.h>
#include <stdio.h>
#include <stdlib.h>
#include <sys/wait.h>

int n=4;

int foo(const char *whoami) {
    printf("I am a %s. My pid is:%d my ppid is %d\n", whoami, getpid(), getppid());
    return 1;
}

int func(int n)
{
    if (n == 0)
```

```

    {
        return 0;
    }
    int pid = fork();
    if (pid == -1) {
        exit(0);
    }
    if (pid==0) {
        foo("child");
        n = n-1;
        func(n);
        exit(0);
    }
    else {
        wait(NULL);
    }
    return 0;
}

int main()
{
    func(n);
    return 0;
}

```

## Output:

```

nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3/Submission
gcc chainOfProcesses
nevil11@nevil11-Ideapad-Z560: ~/Desktop/OS LAB 3/Submission$ ./a.out
I am a child. My pid is: 26411 my ppid is 26410
I am a child. My pid is: 26412 my ppid is 26411
I am a child. My pid is: 26413 my ppid is 26412
I am a child. My pid is: 26414 my ppid is 26413

```