

МГТУ им. БАУМАНА

ЛАБОРАТОРНАЯ РАБОТА №5

По курсу: "ОПЕРАЦИОННЫЕ СИСТЕМЫ"

**Процессы.
Системные вызовы `fork()` и `exec()`.**

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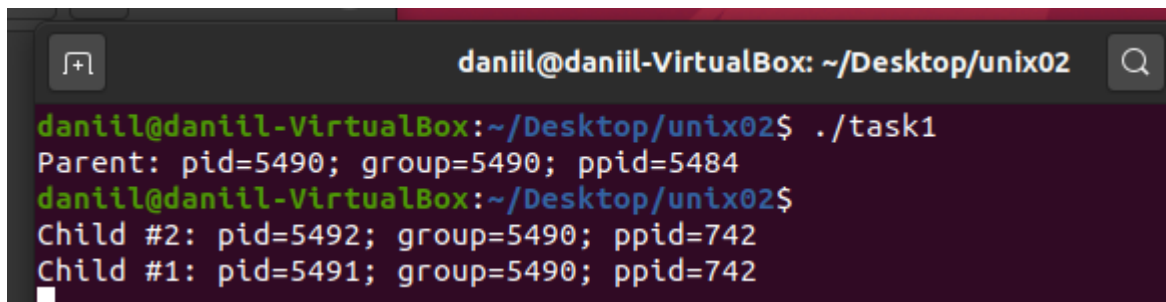
Москва, 2020

0.1 Листинг кода алгоритмов

В данном разделе будут приведены листинги кода реализованных программ.

Листинг 1: Процессы-сироты

```
1 #include <stdio.h>
2 #include <stdlib.h>
3
4 int main(){
5     int child_1, child_2;
6     child_1 = fork();
7     if(child_1 == -1){
8         perror("Coulnd't fork child #1");
9         exit(1);
10    }
11    if (child_1 == 0){
12        sleep(1);
13        printf("Child #1: pid=%d; group=%d; ppid=%d\n",
14            getpid(), getpgrp(), getppid());
15
16        return 0;
17    }
18    if (child_1 > 0){
19        child_2 = fork();
20        if(child_2 == -1){
21            perror("Coulnd't fork child #2");
22            exit(1);
23        }
24        if (child_2 == 0){
25            printf("\nChild #2: pid=%d; group=%d; ppid=%d\n",
26                getpid(), getpgrp(), getppid());
27
28            return 0;
29        }else{
30            printf("Parent: pid=%d; group=%d; ppid=%d\n",
31                getpid(), getpgrp(), getppid());
32
33            return 0;
34        }
35    }
36 }
```



The image shows a terminal window titled "daniil@daniil-VirtualBox: ~/Desktop/unix02". The prompt is "daniil@daniil-VirtualBox:~/Desktop/unix02\$". The user enters the command "./task1". The output is "Parent: pid=5490; group=5490; ppid=5484". The prompt changes to "daniil@daniil-VirtualBox:~/Desktop/unix02\$". The user enters the command "Child #2: pid=5492; group=5490; ppid=742". The output is "Child #1: pid=5491; group=5490; ppid=742".

```
daniil@daniil-VirtualBox:~/Desktop/unix02$ ./task1
Parent: pid=5490; group=5490; ppid=5484
daniil@daniil-VirtualBox:~/Desktop/unix02$
Child #2: pid=5492; group=5490; ppid=742
Child #1: pid=5491; group=5490; ppid=742
```

Рис. 1: Пример работы программы №1

```
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <sys/types.h>
4 #include <sys/wait.h>
5
6 int main(){
7     int child_1, child_2;
8     child_1 = fork();
9     if(child_1 == -1){
10         perror("Coulnd't fork child #1");
11         exit(1);
12     }
13     if (child_1 == 0){
14         sleep(1);
15         printf("Child #1: pid=%d; group=%d; ppid=%d\n",
16             getpid(), getpgrp(), getppid());
17
18         return 0;
19     }
20     if (child_1 > 0){
21         child_2 = fork();
22         if(child_2 == -1){
23             perror("Coulnd't fork child #2");
24             exit(1);
25         }
26         if (child_2 == 0){
27             printf("\nChild #2: pid=%d; group=%d; ppid=%d\n",
28                 getpid(), getpgrp(), getppid());
29
30             return 0;
31         }else{
32             sleep(2);
33             printf("Parent: pid=%d; group=%d; ppid=%d\n",
34                 getpid(), getpgrp(), getppid());
35
36             pid_t child_pid;
37             int status;
38
39             child_pid = wait(&status);
40             if (WIFEXITED(status))
41                 printf("Parent: child %d finished with code %d\n",
42                     child_pid, WEXITSTATUS(status) );
43             else if (WIFSTOPPED(status))
44                 printf("Parent: child %d finished with code %d\n",
45                     child_pid, WSTOPSIG(status) );
46             return 0;
47         }
48     }
```

```
daniil@daniil-VirtualBox:~/Desktop/unix02$ ./task2  
  
Child #2: pid=5891; group=5889; ppid=5889  
Child #1: pid=5890; group=5889; ppid=5889  
Parent: pid=5889; group=5889; ppid=5879  
Parent: child 5890 finished with code 0  
daniil@daniil-VirtualBox:~/Desktop/unix02$
```

Рис. 2: Пример работы программы №2

```
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <unistd.h>
4
5 int main(){
6     int child_1, child_2;
7     child_1 = fork();
8     if(child_1 == -1){
9         perror("Coulnd't fork child #1");
10        exit(1);
11    }
12    if (child_1 == 0){
13        sleep(1);
14        printf("\nChild #1 executes ps -al\n\n");
15        if(execlp("ps", "ps", "-al", (char*)NULL) == -1){
16            printf("Couldn't exec ps command\n");
17            exit(1);
18        }
19
20        return 0;
21    }
22    if (child_1 > 0){
23        child_2 = fork();
24        if(child_2 == -1){
25            perror("Coulnd't fork child #2");
26            exit(1);
27        }
28        if (child_2 == 0){
29            printf("\nChild #2 executes ls -l\n\n");
30            if(execlp("ls", "ls", "-l", (char*)NULL) == -1){
31                printf("Couldn't exec ps command\n");
32                exit(1);
33            }
34            return 0;
35        }else{
36            printf("\nParent: pid=%d; group=%d; ppid=%d\n",
37                getpid(), getpgrp(), getppid());
38
39            pid_t child_pid;
40            int status;
41
42            //waiting for the second child to finish
43            child_pid = wait(&status);
44            if (WIFEXITED(status))
45                printf("\nParent: child with pid = %d finished with code %d\n",
46                    child_pid, WEXITSTATUS(status) );
47            else if (WIFSTOPPED(status))
48                printf("\nParent: child %d finished with code %d\n",
```

```

49         child_pid, WSTOPSIG(status) );
50
51     //waiting for the first child to finish
52     child_pid = wait(&status);
53     if (WIFEXITED(status))
54         printf("\nParent: child with pid = %d finished with code %d\n",
55             child_pid, WEXITSTATUS(status) );
56     else if (WIFSTOPPED(status))
57         printf("\nParent: child %d finished with code %d\n",
58             child_pid, WSTOPSIG(status) );
59
60     return 0;
61     }
62 }
63 }

```

```

danil@danil-VirtualBox:~/Desktop/unix02$ ./task3
Parent: pid=5957; group=5957; ppid=5879

Child #2 executes ls -l

total 120
-rwxrwxr-x 1 danil danil 17000 ноя  8 18:26 task1
-rw-rw-r-- 1 danil danil   734 ноя  8 18:28 task1.c
-rwxrwxr-x 1 danil danil 17096 ноя  9 15:52 task2
-rw-rw-r-- 1 danil danil  1121 ноя  9 16:01 task2.c
-rwxrwxr-x 1 danil danil 17184 ноя  9 16:29 task3
-rw-rw-r-- 1 danil danil  1633 ноя  9 16:29 task3.c
-rwxrwxr-x 1 danil danil 17176 ноя  9 17:06 task4
-rw-rw-r-- 1 danil danil  1903 ноя  9 17:17 task4.c
-rwxrwxr-x 1 danil danil 17256 ноя 10 18:39 task5
-rw-rw-r-- 1 danil danil  2132 ноя 10 18:40 task5.c
.
| Parent: child with pid = 5959 finished with code 0

Child #1 executes ps -al
ng-
 F S  UID      PID      PPID  C PRI  NI ADDR SZ WCHAN  TTY          TIME CMD
ere4 S   1000        830        822  0  80   0 - 76634 ep_pol  tty2        00:00:28 Xorg
0 S   1000        942        822  0  80   0 - 47711 poll_s  tty2        00:00:00 gnome-sess
0 S   1000       5957       5879  0  80   0 -    622 do_wai pts/0        00:00:00 task3
4 R   1000       5958       5957  0  80   0 -   2850 -      pts/0        00:00:00 ps

Parent: child with pid = 5958 finished with code 0
danil@danil-VirtualBox:~/Desktop/unix02$

```

Рис. 3: Пример работы программы №3

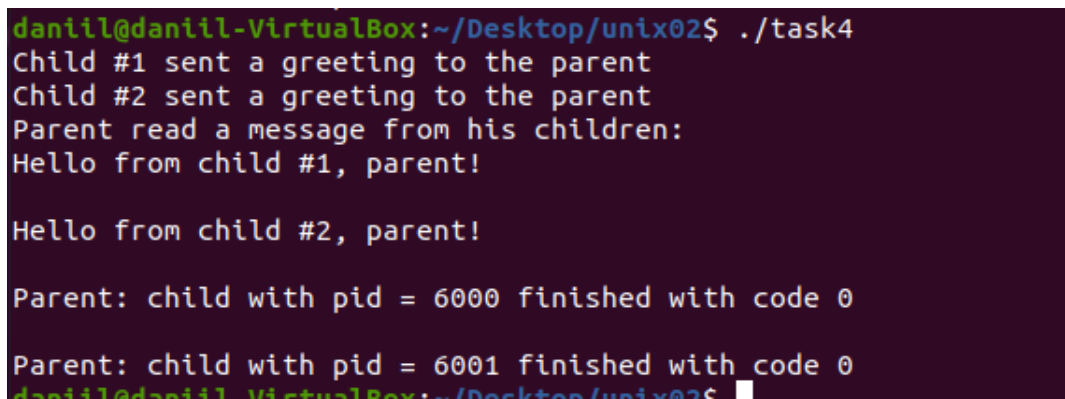
```
1  /*
2  exchanging messages with parent
3  */
4  #include <stdio.h>
5  #include <stdlib.h>
6  #include <unistd.h>
7  #define MESSAGE_SIZE 32
8
9  int main(){
10     int child_1, child_2;
11
12     //initializing pipe
13     int fd[2];
14     if (pipe(fd) == -1){
15         printf("Coundn't create a pipe\n");
16         exit(1);
17     }
18
19     child_1 = fork();
20     if(child_1 == -1){
21         perror("Coulnd't fork child #1");
22         exit(1);
23     }
24     if (child_1 == 0){
25
26
27         close(fd[0]);
28         if (write(fd[1], "Hello from child #1, parent!\n",
29             MESSAGE_SIZE) > 0)
30             printf("Child #1 sent a greeting to the parent\n");
31         return 0;
32     }
33     if (child_1 > 0){
34         child_2 = fork();
35         if(child_2 == -1){
36             perror("Coulnd't fork child #2");
37             exit(1);
38         }
39         if (child_2 == 0){
40             sleep(1);
41             close(fd[0]);
42             if (write(fd[1], "Hello from child #2, parent!\n",
43                 MESSAGE_SIZE) > 0)
44                 printf("Child #2 sent a greeting to the parent\n");
45             return 0;
46         }else{
47
48             char msg1[MESSAGE_SIZE], msg2[MESSAGE_SIZE];
```



```

49     close(fd[1]);
50     read(fd[0], msg1, MESSAGE_SIZE);
51     read(fd[0], msg2, MESSAGE_SIZE);
52
53     printf("Parent read a message from his children: \n%s\n%s",
54           msg1, msg2);
55
56
57
58     pid_t child_pid;
59     int status;
60
61     //waiting for the second child to finish
62     child_pid = wait(&status);
63     if (WIFEXITED(status))
64         printf("\nParent: child with pid = %d finished with code %d\n",
65               child_pid, WEXITSTATUS(status) );
66     else if (WIFSTOPPED(status))
67         printf("\nParent: child %d finished with code %d\n",
68               child_pid, WSTOPSIG(status) );
69
70     //waiting for the first child to finish
71     child_pid = wait(&status);
72     if (WIFEXITED(status))
73         printf("\nParent: child with pid = %d finished with code %d\n",
74               child_pid, WEXITSTATUS(status) );
75     else if (WIFSTOPPED(status))
76         printf("\nParent: child %d finished with code %d\n",
77               child_pid, WSTOPSIG(status) );
78
79     return 0;
80 }
81 }
82 }

```



```

daniil@daniil-VirtualBox:~/Desktop/unix02$ ./task4
Child #1 sent a greeting to the parent
Child #2 sent a greeting to the parent
Parent read a message from his children:
Hello from child #1, parent!

Hello from child #2, parent!

Parent: child with pid = 6000 finished with code 0

Parent: child with pid = 6001 finished with code 0
daniil@daniil-VirtualBox:~/Desktop/unix02$

```

Рис. 4: Пример работы программы №4

```
1  /*
2  DIY sig handler
3  */
4  #include <stdio.h>
5  #include <stdlib.h>
6  #include <unistd.h>
7  #include <signal.h>
8  #include <stdbool.h>
9  #include <string.h>
10
11 #define MESSAGE_SIZE 64
12 #define SLEEP_TIME 3
13
14 //flag is set to true if signal has been caught
15 bool flag = false;
16
17 void mySignalHandler(int snum){
18     printf("\nHandlig signal snum = %d in prosses...\n", snum);
19     printf("Done!\n");
20     flag = true;
21 }
22
23 int main(){
24     int child_1, child_2;
25     signal(SIGINT, mySignalHandler);
26
27     //initializing pipe
28     int fd[2];
29     if (pipe(fd) == -1){
30         printf("Coundn't create a pipe\n");
31         exit(1);
32     }
33
34     child_1 = fork();
35     if(child_1 == -1){
36         perror("Coulnd't fork child #1");
37         exit(1);
38     }
39     if (child_1 == 0){
40         close(fd[1]);
41         sleep(SLEEP_TIME);
42         if (flag){
43             char msg[MESSAGE_SIZE];
44             if (read(fd[0], msg, MESSAGE_SIZE) > 0){
45                 printf("Child #1 read from parent %s\n", msg);
46             }
47         }
48     }
```

```

49     return 0;
50 }
51 if (child_1 > 0){
52     child_2 = fork();
53     if(child_2 == -1){
54         perror("Couldn't fork child #2");
55         exit(1);
56     }
57     if (child_2 == 0){
58         close(fd[1]);
59
60         sleep(SLEEP_TIME);
61         if (flag){
62             char msg[MESSAGE_SIZE];
63             if (read(fd[0], msg, MESSAGE_SIZE) > 0){
64                 printf("Child #2 read from parent %s\n", msg);
65             }
66         }
67
68         return 0;
69     }else{
70         close(fd[0]);
71         printf("Parent's waiting for Ctrl+C being pressed to send messages↵
72             from children\n");
73         sleep(SLEEP_TIME);
74
75         if (flag){
76             //writing in pipe if we caught the signal
77             if (write(fd[1], "Hello, my child!\n", MESSAGE_SIZE) > 0)
78                 printf("Parent sent his first greeting\n");
79             if (write(fd[1], "Hello again, my child!\n", MESSAGE_SIZE) > 0)
80                 printf("Parent sent his second greeting\n");
81         }
82
83         pid_t child_pid;
84         int status;
85
86         //waiting for the second child to finish
87         child_pid = wait(&status);
88         if (WIFEXITED(status))
89             printf("Parent: child with pid = %d finished with code %d\n",
90                 child_pid, WEXITSTATUS(status) );
91         else if (WIFSTOPPED(status))
92             printf("Parent: child %d finished with code %d\n",
93                 child_pid, WSTOPSIG(status) );
94
95         //waiting for the first child to finish
96         child_pid = wait(&status);
97         if (WIFEXITED(status))

```

```

97     printf("Parent: child with pid = %d finished with code %d\n",
98           child_pid, WEXITSTATUS(status) );
99     else if (WIFSTOPPED(status))
100     printf("Parent: child %d finished with code %d\n",
101           child_pid, WSTOPSIG(status) );
102     return 0;
103 }
104 }
105 }

```



```

danil@danil-VirtualBox:~/Desktop/operating-system/sem 5/lab05$ ./task5
Parent's waiting for Ctrl+C being pressed to send messages from children
^C
Handlig signal snum = 2 in prosses...
Done!
Parent sent his first greeting
Parent sent his second greeting

Handlig signal snum = 2 in prosses...
Done!
Child #2 read from parent Hello, my child!

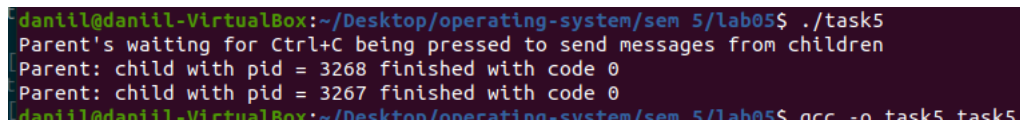
Parent: child with pid = 3276 finished with code 0

Handlig signal snum = 2 in prosses...
Done!
Child #1 read from parent Hello again, my child!

Parent: child with pid = 3275 finished with code 0
danil@danil-VirtualBox:~/Desktop/operating-system/sem 5/lab05$ qit status

```

Рис. 5: Пример работы программы №5: был подан сигнал



```

danil@danil-VirtualBox:~/Desktop/operating-system/sem 5/lab05$ ./task5
Parent's waiting for Ctrl+C being pressed to send messages from children
Parent: child with pid = 3268 finished with code 0
Parent: child with pid = 3267 finished with code 0
danil@danil-VirtualBox:~/Desktop/operating-system/sem 5/lab05$ gcc -o task5 task5

```

Рис. 6: Пример работы программы №5: сигнал не был подан