UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Departamento de Informática de Sistemas y Computadores (DISCA)

fSO

EEE1: Ejercicio de Evaluación
November, 6th 2017

etsinf — Escola Tècnica Superior d'Enginyeria Informàtica

SURNAME		NAME		Group
ID		Signature		

- **Keep the exam sheets stapled.**
- **Write your answer inside the reserved space.**
- **Use clear and understandable writing. Answer briefly and precisely.**
- **The exam has 7 questions, everyone has its score specified.**

1. Terms shell, system calls, time sharing and software interrupt or trap are essential when it comes to an operating system like UNIX. Write a brief description of every term and indicate what they are useful for.

(**1.2 points** = 0,3 + 0,3 + 0,3 + 0,3)

1	**a)** Shell (define and explain its utility) It is a software application that reads the command line and then analyzes and executes it. To this a file with executable code that corresponds to the command to be executed. It is a utility provided with the operating system but not part of it. This software does system calls to create processes and to access I/O devices. It runs as a user process Useful to work from the terminal and to access to computer resources.
	b) System call (define and explain its utility) System calls are the interface offered by the operating system to request services and access hardware and software system resources. System calls cause the operating system intervention and the CPU execution mode changes from user mode to kernel mode. Kernel mode can run the full instruction set (both privileged and nonprivileged instructions) and also allows accessing to all I/O devices, memory, etc. System calls are useful to request operating system services and to access protected resources.
	c) Time sharing (define and explain its utility) Those operating systems, besides allowing multiprogramming or concurrent process execution, they enable direct user-machine interaction through terminals. So they are operating systems that allow the user to work in front of the machine, and then working more efficiently.
	d) Software interrupt or trap (define and explain its utility) It is an interrupt that is caused by an instruction or a system call . It is useful to perform the intervention of the operating system, and so it implies a change to kernel mode.

2. Given the following C program named Test.c, that has generated the executable file named “Test”:

```c
/*** Test.c ***/
#include “all required: stdio.h, stdlib.h, unistd.h”

int main(int argc, char *argv[]) {
  pid_ t val;

  if (argc==1) {
    if (execl("/bin/ls", "ls","-la",NULL)<0) {
      printf ("Message 1\n",1);  exit(1);
    }
  } else if (argc==2) {
    val= fork();
    if (execl("/bin/cat", "cat",argv[1],NULL)<0) {
      printf("Message 2\n");  exit(2);
    }
  }
  while (wait(NULL)!=-1) printf ("waiting \n");
  printf("Message 3\n");
  exit(0);
}
```

Explain how many processes are created, the relationship between them and the information displayed on standard output by its execution with the following commands:

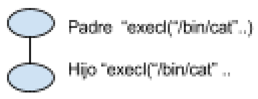
(1.5 points = 0,75 + 0,75)

2

a) `$ ./Test`

Running ./Test (with no arguments) provides argc == 1, the a single process is created that changes its memory image by the code in /bin/ls and then it displays the result of executing the command "ls -la"screen, that is the contents of the current directory in long format.

b) `$ ./Test Test.c`

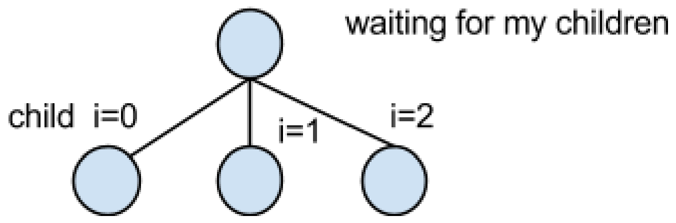


When running "./Test Test.c" condition argc == 2 is met and so two processes are created, parent and child. As the returned value by fork () call is not checked, both processes run "execl ("/bin/cat"," cat ", argv [1], NULL)" which changes its memory image by the code in /bin/cat. The the contents of file Test.c is shown twice on the screen.

3. Complete the following code in order to create the process scheme shown on the picture, in such a way that:

(a) All children have to stay zombies for about 10 seconds, they have to end calling to exit(i), where "i" is the variable that controls the children creation loop.

(b) The parent must wait for all his children and then it has to show on the terminal the value passed by every child through exit().



(1.4 points)

3

```
/*** Example.c ***/
#include "all required.h"
#define N 3
int main(int argc, char *argv[]) {
  int i, status;
  pid_t val;

  printf("Parent \n");
  for(i=0; i<N; i++) {
    val= fork();
    if ( val==0 ) {
      printf("I'm a child\n");
      exit(i);
    } /* val**/
  }

  sleep(10);
  while (wait(&status)!=-1) {
    printf ("waiting  status= %d \n", status/256);
  }



  printf("END \n");
  exit(0);
}
```

4. A short term scheduler on a timesharing system has two queues: F-Queue that is FCFS and R-Queue that is Round Robin with q = 10ut. New processes and those coming from I/O always go to R-Queue. R-Queue has more priority than F-Queue, a process is demoted to F-Queue after consuming a CPU quantum. Inter-queue scheduling is preemptive priorities. All I/O operations are performed on a single device with FCFS queue. In this system the following set of processes is requested to run:

Process	Arrival time	CPU and I/O bursts
A	0	30 CPU + 10 I/O + 30 CPU + 10 I/O + 30 CPU
B	2	10 CPU + 30 I/O + 10 CPU + 30 I/O + 10 CPU
C	4	20 CPU + 20 I/O + 20 CPU + 20 I/O +20 CPU

a) Obtain the execution timeline, filling the table below. Notice that time intervals are 10 ut .

(**2.3 points** = 1.3 + 0.6 + 0.4)

T	R-Queue	F-Queue	CPU	I/O Queue	I/O	Event
0	[C,B] (A)		A			A(0),B(2) and C(4)arrive
10	C,(B)	A	B			
20	(C)	A	C		B	B to I/O
30		C,(A)	A		B	
40		C	A		B	B outs I/O
50	(B)	C	**B**	(A)	A	B goes ahead of C
60	(A)	C	A	(B)	B	
70		A,(C)	C		B	
80		(A)	A	C	B	B outs I/O
90	(B)	A	**B**		C	B expulsa a A
100			A		C	B ends
110	(C)		C	(A)	A	
120	(A)	C	A			
130		A,(C)	C			
140		(A)	A	(C)	C	
150			A		C	
160	(C)		C			A ends
170			C			
180						C ends

4 b) Obtain the waiting times and the turnaround times for every process.

	Waiting time	Turnaround time
A	**50**	160-0 = **160**
B	**8 (0)**	100-2 = **98**
C	**66 (60)**	180-4 = **176**

4 c) Briefly explain if the scheduler gives some kind of preference to CPU bound processes or I/O bound processes

It gives preference to I/O bound processes, in the sense that they wait less time on the ready queue. On the one hand, having short CPU bursts, make them less likely to be degraded to FCFS queue, that has less priority. Furthermore, if the process has many I/O bursts, every time an I/O burst finishes the process returns to RR queue that has higher priority.

5. Access protocols to the critical section should meet three requirements: mutual exclusion, progress and limited waiting. Indicate for each of the following proposals if mutual exclusion is verified (YES) or not (NO). In case of verifying mutual exclusion then answer if the other two requirements are met or not.

(**1.6 points** = 0,4 + 0,4 + 0,4 + 0,4)

5		Mutual exclusion	Progress	Limited waiting

	`semaphore S=1 // shared variable with FIFO queue`
	`Input protocol -> P(S)`
	`        Critical section();`
	`Output protocol -> V(S)`
		YES	YES	YES

	`int key = 0;   // shared variable`
	`Input protocol -> while (key ==1);`
	`        key = 1;`
	`        Critical section();`
	`Output protocol -> key = 0;`
		NO	NO	NO

	`// Hardware solution`
	`Input protocol -> DI; // Disable interrupts`
	`        Critical section();`
	`Output protocol -> EI;  // Enable interrupts`
		YES	YES	NO

	`int key = 0;  // shared variable`
	`Input protocol -> while (test_and_set(&key));`
	`        Critical section();`
	`Output protocol -> key = 0;`
		YES	YES	NO

6. A swimming pool has set a maximum number of 100 simultaneous swimmers. A swimmer has to perform operation GetHat() in order to be able to do Swim(). A "swimmer" is implemented as a thread that executes function FuncSwim(). There is a thread "collector" that puts hats on a shelf executing function FuncCollect(). Add the required operations on the semaphores declared and initialized in main(), so the following code comply with these requirements:

- Both functions GetHat() and PutHat() are executed in mutual exclusion.
- A "swimmer" thread has to call to GetHat() before calling to Swim().
- The hat shelf size is 100.
- Thread "collector" has to be able to call to PutHat() if there is a gap on the hat shelf (number of hats < 100)
- If the hat shelf if full then "collector" thread has to be suspended.
- The maximum number of "swimmer" threads simultaneously on Swim() is 100.
- Every time a "swimmer" ends Swim() another one will do Swin() if it has already a hat.
- If there are 100 "swimmer"s on Swim() then another one trying to Swim() has to be suspended.

Note. You can use for semaphore operations Disktra notation P() and V() or POSIX sem_wait(), sem_post().

(1.0 point)

6

```
#include <all requred...>
 sem_t swim_swimmers, hats, mutex;    // semaphores declaration

int main(int argc, char *argv[]) {
    pthread_attr_t attr;
    pthread_t swimmer[300], collector;
    int i;
    pthread_attr_init(&attr);
    sem_init(&swim_swimmers,0,0); sem_init(&hats,0,100); sem_init(&mutex,0,1);
    pthread_create(&collector, &attr, FuncCollect, NULL);
    for (i = 0; i < 300; i++) pthread_create(&swimmer[i], &attr, FuncSwim, NULL);
    for (i = 0; i < 300; i++) pthread_join(swimmer[i], NULL);
}
void *FuncSwim(void *arg) {
    // Complete to comply with enunciate requirements
    P(hats)
    P(mutex);
    GetHat();
    V(mutex);
    Swim();
    V(swim_swimmers);
}
void *FuncCollect(void *arg) {
    // Complete to comply with enunciate requirements
    while(1) {
        P(swim_swimmers);
        P(mutex);
        PutHat();
        V(mutex);
        V(hats);
    }
}
```

7. Obtain the strings that will be printed on the terminal after running the following program. Explain your answer.

(1.0 point)

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <pthread.h>

pthread_t  th1, th2;
pthread_attr_t atrib;

void *Func_th1(void *arg) {
  int i,j;
  i= *((int *)arg);
  j=1;
  sleep(10+i);
  pthread_join(th2,NULL);
  printf("th1 is awake\n");
  pthread_exit(&j);
}
```

```
void *Func_th2(void *arg) {
  int i,j;
  i= *((int *)arg);
  j=2;
  sleep(20+i);
  printf("th2 is awake\n");
  pthread_exit(&j);
}
```

```
int main (int argc, char *argv[]) {
  int i;

  pthread_attr_init(&atrib);
  printf("Pthread message: \n");
  i= rand();       // function that provides a random number
  pthread_create(&th1, &atrib, Func_th1,&i);
  pthread_create(&th2, &atrib, Func_th2,&i);

  printf("END \n");
  exit(0);
}
```

7	Pthread message: END The main thread doesn’t call to pthread_join so the complete process finishes when calling to exit(0).