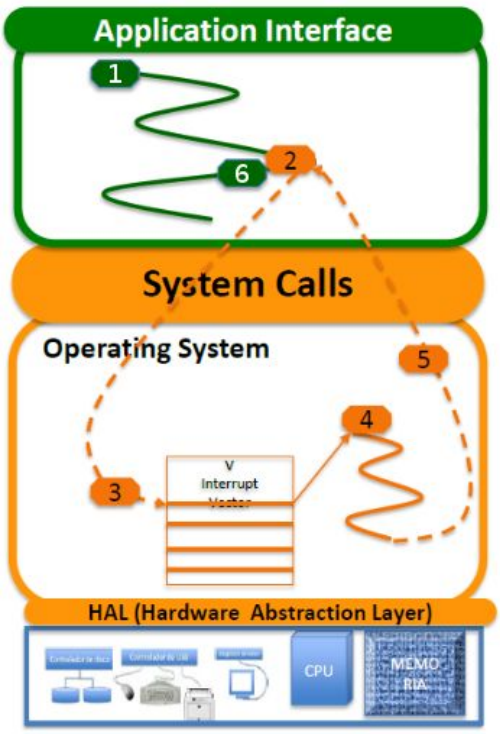
SURNAME		NAME		Group
ID		Signature		

- **Keep the exam sheets stapled.**
- **Write your answer inside the reserved space.**
- **Use clear and understandable writing. Answer briefly and precisely.**
- **The exam has 9 questions, everyone has its score specified.**
- **Remember that you have to appropriately explain your answers to get the full corresponding score**

1. Describe the events numbered from 3 to 6 in the figure, related to the request of a system call by a user process, and indicate in "Mode:" the CPU operating mode that corresponds to the execution of each one of the numbered events .

(0,9 points)

1		**EVENT 1** **Description:** User program in execution **Mode:** **EVENT 2** **Description:** System call **Mode:** **EVENT 3** **Description:** **Mode:** **EVENT 4** **Description:** **Mode:** **EVENT 5** **Description:** **Mode:** **EVENT 6** **Description:** **Mode:**

2. Given the following code whose executable file is *example1*:

```
 1 /*** example1***/
 2 #include "head required.h"
 3
 4 int main() {
 5   int i=0, delay1=1, delay2=1;
 6   pid_t pid, pid_x;
 7
 8   for (i=0; i<2; i++) {
 9     pid=fork()
10     if (pid==0) {
11       sleep(delay1);
12       if(execlp("wc","wc","-l","example1.c",NULL)<0) {
13         printf("Error running wc\n");
14         exit(0); }
15       pid_x=fork();
16     }
17   }
18   sleep(delay2);
19   while (wait(NULL) =! -1);
20   exit(0);
21 }
```

Supposing that example1 runs without errors, answer to the following: **(1,0 points = 0,5 + 0,5)**

2	**a)** Number of processes that are generated when executing example1 and draw the processes tree .
	b) Indicate with the corresponding explanation the possibility of generating zombie or orphan processes for each of the following pairs of values of *delay1* and *delay2*: ***b1)*** *delay1=1000; delay2=10*; ***b2)*** *delay1=10: delay2=1000*;

3. A time-sharing system has a Round Robin short-term process scheduler, with quantum **q = 2 tu** and a single ready queue. When several events occur simultaneously then the order of insertion in the ready queue is: new process, coming from I/O and coming from CPU (quantum end). The following table shows an scheduling for processes A, B and C, that arrive at instants t = 0, t = 3 and t = 8 respectively, and whose standing alone processing descriptions are:

A (t=0)	4CPU+ 2I/O + 4CPU + 3I/O + 1CPU

B (t=3)	6CPU + 1I/O + 2CPU

C(t=8)	3CPU+2I/O+1CPU

Due to an implementation failure, the scheduler does not work according to the proposed specifications and so it makes mistakes. Detect in the table the instant when an error occurs for the first time, indicate the error reason and do again the scheduling from that instant in the available empty columns on the table.

(1,2 points = 0,9 + 0,3)

T	Ready Q	CPU	I/O Q	I/O	Ready Q	CPU	I/O Q	I/O	Event
0	(A)	A							A arrives
1		A							
2		A							
3	B	A							B arrives
4	(B)	B	(A)	A					
5		B		A					
6	B(A)	A							
7	B	A							
8	C A(B)	B							C arrives
9	C A	B							
10	B C(A)	A							
11	B C	A							
12	B(C)	C	(A)	A					
13	B	C		A					
14	C(B)	B		A					
15	A C	B							
16	A(C)	C	(B)	B					
17	B (A)	A	(C)	C					
18	(B)	B		C					A ends
19	C	B							
20	(C)	C							B ends
21									C ends
22									
23									

3

a) Error time instant T =
Reason why:

b) Indicate the turnaround time and the waiting time for every process:

	A	B	C
Turnaround time			
Waiting time			

4. Given the following string of 52 characters corresponding to a DNA gene:
CACTCAGCACGAA GGGCAGAGGAATG CTTACCGTCCTGA GCCACCCACCAGC

We want to find in what positions the CAG amino acid is referenced, with a design based on 4 concurrent threads. Each thread analyzes a single fraction of 13 characters of the gene, so that one thread analyzes the first 13 characters, another the 13 following, etc. The function "find_amino" receives a pointer to the position of the first character of the fraction that the assigned thread has to process and, in case of finding the amino acid in that fraction, marks the first character where it appears by overwriting the corresponding character 'C' by '*'. The main program, after making sure that all the occurrences of the amino acid have been marked, looks for the marked positions and sends them to the standard output in order, separated by an space. **(1,0 points = 0,5 + 0,25 + 0,25)**

```
 1 #include <all_needed.h>
 2 #define NFRAC 4
 3 #define GENSIZE 52
 4
 5 char gen[] = "CACTCAGCACGAAGGGCAGAGGAATG
 6 CTTACCGTCCTGAGCCACCCACCAGC";
 7 char amino[] = "CAG";
 8
 9 void *find_amino(void *ptr) {
10   char *pgen= (char*) ptr;
11   int i;
12   for (i=0; i<GENSIZE/NFRAC-2; i++) {
13     if (pgen[i] == amino[0] &&
14         pgen[i+1] == amino[1] &&
15         pgen[i+2] == amino[2])
16       pgen[i] = '*';
17 }
```

```
18 int main() {
19   int i;
20   char *pfrac;
21   pthread_attr_t attrib;
22   pthread_t thread[NFRAC];
23   pthread_attr_init(&attrib);
24
25   for (i = 0; i<NFRAC; i++) {
26     pfrac= gen + i * GENSIZE/NFRAC;
27
28 /**complete**/
...
     for (i = 0; i<GENSIZE; i++) {
       if (gen[i]=='*')
          printf("%d ", i);
  }
```

4 **a)** Use the variables already declared in the program and fill in the missing lines of code in the space marked as "/ ** complete ** /", so that the creation and waiting of the 4 threads "find_amino" according to the problem solution proposed.

NOTE. Functions definition:

*int pthread_join(pthread_t thread, void **retval);*

*int pthread_create(pthread_t *thread, const pthread_attr_t *attr, void *(*start_routine) (void *), void *arg);*

```
25 for (i = 0; i<NFRAC; i++){
26   pfrac= gen + i * GENSIZE/NFRAC;
```

b) Explain what is the maximum number of threads belonging to this process that will run concurrently.

c) Explain if this program execution may lead to any race condition.

5. Given the following code of three concurrent processes whose initial values of variable X and semaphores S1, S2 are the following: X = 1, S1 = 1, S2 = 1.

A	B	C
P(S1); X = X + 1; V(S1);	P(S1); V(S1); P(S2); X = X - 1; V(S2);	P(S1); P(S2); X = X + 1; V(S2);

These three processes are executed in a system where the order in which the processor is assigned for the first time is ALWAYS determined by the order of arrival in the ready queue. After getting the CPU for the first time, the first instruction (P (S1)) is ALWAYS executed, but from that point on, context changes can happen at any time. Indicate for every given sequence: **1.** If the three processes can end; **2.** If it is possible for a race condition to happen and; **3.** The final value of X, if all processes end.

(1,0 points = 0,5 + 0,5)

5

a) A, B, C

b) B, A, C

6. A system with 4 GBytes of main memory uses demand paging with an LRU as replacement algorithm, with **LOCAL** scope. The logical address space is 4 GBytes and the page size is 4 KBytes. At a given moment the execution of processes A and B begins, and the system assigns 4 frames (numbered from 0 to 3) for A and B that are distributed according to fair allocation. All frames are initially empty .

(1,6 points = 0,2 + 0,8 + 0,6)

6

a) Obtain the reference string from the following sequence of logical addresses (in hexadecimal):
(A:1A407125) (A:1A4072C9) (A:4FB30190) (B:00400000) (A:1A407C41) (B:1000458F) (A:24B71AFF) (B:1E861100) (B:1E861ABC) (A:1A407642) (B:0040093C) (A:4FB30456)

b) Indicate the evolution of main memory content for the reference string obtained in section a). Frames are assigned in increasing order. Also indicate where page faults happen.

Frame										
0										
1										
2										
3										

TOTAL PAGE FAULTS :

c) After the reference string in section b), two new logical addresses are generated: (A: 1A407FFF) and (B: 1E861008). Explain what physical addresses the MMU will generate for each of them.

7. Considering the inheritance mechanism in Unix processes and POSIX calls, answer the following sections:

(1,3 points = 0,6 + 0,7)

7

a) Fill the file descriptor tables, indicating the content of the non-empty descriptors, during the execution of each of the processes involved in the following command:

```
$ ls -l 2> err | tee f1 | grep ".c" > f2
```

The command has to run and end correctly. Remember that **tee** command writes its standard input in both the file that is passed to it as a parameter and the standard output.

NOTE. Name the first pipe "pipeA" and the second one "pipeB"

ls	
0	
1	
2	
3	
4	

tee	
0	
1	
2	
3	
4	

grep	
0	
1	
2	
3	
4	

b) Supposing that system calls execute without errors, complete the following C program with the required sentences and system calls (one in each line with its number underlined) so that its execution be equivalent to the following command line : `$ ls -l 2> err | tee f1 | grep ".c" > f2`

```
 1. #include <all_needed.h>
 2. #define newfile (O_RDWR | O_CREAT | O_TRUNC)
 3. #define mode644 (S_IRUSR | S_IWUSR | S_IRGRP | S_IROTH)
 4. int main() {
 5.     int pipeA[2], pipeB[2], fd;
 6.
 7.     if (fork()) {
 8.         fd = open("err", newfile, mode644);
 9.
10.
11.         close(pipeA[0]); close(pipeA[1]); close(fd);
12.         execlp("ls", "-l", NULL);
13.      } else {
14.         pipe(pipeB);
15.         if (fork()) {
16.             dup2(pipeA[0], STDIN_FILENO);
17.             dup2(pipeB[1], STDOUT_FILENO);
18.             close(pipeA[0]); close(pipeA[1]);
19.             close(pipeB[0]); close(pipeB[1]);
20.             execlp(                                    ); /*complete*/
21.         } else {
22.             close(pipeA[0]); close(pipeA[1]);
23.             fd = open(                                  ); /*complete*/
24.
25.
26.             close(pipeB[0]); close(pipeB[1]); close(fd);
27.             execlp("grep", "grep", ".c", NULL);
28.         }
29.    }
30.    return 0;
31. }
```

8. Given the following listing corresponding to the contents of a directory in a POSIX system:

```
 i-node    permissions links   user   group    size    date         name
32448485   drwxrwxr-x   2      pep   alumne     4096 ene  8  11:57  .
       1   drwxr-xr-x  11      pep   alumne   236871 ene  8  12:02  ..
32448793   -rw-rw----   1      pep   alumne      310 ene  9  10:37  f1
32448802   --w-rw-r--   3      pep   alumne      343 ene  9  11:15  f3
32448805   -rw----r--   3      pep   alumne      343 ene  9  10:33  f4
32448752   -rwxrwxrwx   1      pep   alumne     5824 ene  9  15:17  f5
33373385   -r-sr-xr-x   1      ana   alumne      706 ene  9  10:35  cp1
32448804   lrwxrwxrwx   1      ana   alumne        8 ene  9  10:36  cp2 ->cp1
32448803   lrwxrwxrwx   1      ana   profes        8 ene  9  10:40  f2 ->f1
```

Commands `cp1` and `cp2` require the name of two files as arguments: `cp1(or cp2) file1 file2`, result in the content of `file1` being copied to `file2` and if `file2` does not exist then it is created.

(1,0 points = 0,75 + 0,25)

8

a) Rellene la tabla e indique en caso de éxito cuales son los permisos que se comprueban y, en caso de error, cuál es el permiso que falla y porqué.

User	Group	Command	Does it work? (YES OR NO)
ana	**profes**	**./cp1 f1 f3**	
Explain			
pep	**alumne**	**./cp2 f3 f2**	
Explain			
pep	**disca**	**./cp1 f4 f6**	
Explain			

b) Explain what type of file is **f2** and indicate the numbers of the i-nodes that will be required to access in order to read the contents of that file .

9. A 512 MByte Minix file system has the following features:

- 32-Byte i-nodes, with 7 direct pointers to zones, 1 indirect and 1 double indirect
- 16-bit (2-Byte) pointers to zone
- 16-Byte directory entries (14 Bytes for name and 2 Bytes for i-node id)
- **1 Block = 1 Zone = 2 KBytes**

(1,0 points = 0,6 + 0,4)

9 **a)** Obtain the sizes for each header element, considering the file system formated for 16384 (16K) i-nodes.

Boot	Super block	i-node bit map	Zone bit map	i-nodes	Data area

b) Calculate and justify the minimum zone size with which a 512-MByte partition should be formatted if the i-node is designed with only **eight** 32-bit direct pointers to zone, and you want to have files of size up to 256 MBytes. Justify the zone size and what advantages and disadvantages this design has for (large) 256-MByte files and (small) 1-Byte files .