Universidad Carlos III de Madrid
Computer Science and Engineering Department

Operating Systems Course

RULES:

- The final grades and the review dates will be announced in Aula Global. The exam duration is **two hours and a half.** Books and notes are not allowed. A valid ID document will be necessary to submit the exam.

NAME: **GROUP:**

Exercise 2 (20 points).

Answer the following questions. Justify each answer.

a) Why it is not possible to perform a system call using a function similar to CALL?

b) Consider the following program called prog1.c

```
// prog1.c

#include <stdio.h>
#include <unistd.h>
Int main()
{
printf("one\n");
write(STDOUT_FILENO, "two\n", 4);
return 0;
}
```

This program produces the following output when it is executed in command prompt:

```
$ ./prog1
one
two
$
```

However, when the program's output is send to the cat command by means of a pipe, the output is the following one:

```
$ ./prog1 | cat
two
one
```

Explain this behaviour.

c) An user executes in a bash terminal the command **cat < main.c | grep main**
In the following table show each one of the following events:
1. System calls related with the processes: fork, exec, exit, kill, wait/pid
2. System calls related to the file descriptors: open, close, pipe, dup, dup2

The different rows can be used to represent the event synchronization. For instance, if an event n happens after event m, then n has to be placed in a row after event m.

Table for Exercise 2.c

The input is shown in **bold** font and the output is shown in *italic* font.	Shell process	Child1 process	Child2 process
$ **cat < main.c | grep main** *int main() {* $			

Exercise 3 (30 points).

A new Company offers support to investors by means of an automatic learning algorithm based on a decision tree. These tree is used by all the clients and it is constantly updated with new information.

This decision tree is implemented with two routines that are not thread-safe. That is, they are not designed to be used in a concurrent fashion. The names of the routines are eval_investment (to evaluate a given investment) y update_tree (to provide new information to the decission tree).

```
assessment_t* eval_investment(investment_t* input);

void update_tree(features_list* new_features);
```

It is necessary to provide concurrent access to the eval_investment routine and guarantee that when the decision tree is being modified (update_tree) by one thread, no other thread can execute neither eval_investment nor update_tree.

Complete the following tasks:

a) Discuss the related problems of the following solution to the previous requirements.

```
assessment_t* eval_investment_safe( investment_t* input ) {
      pthread_mutex_lock(&m);
      assessment_t* result = eval_investment(input);
      pthread_mutex_unlock(&m);
      return result;
}

void update_tree_safe( features_list* values ) {
      pthread_mutex_lock(&m);
      update_tree(values);
      pthread_mutex_unlock(&m);
}
```

b) Implement an alternative solution for multiple readers/writers using condition variables. The solution has to fulfil the previous requirements.
c) Modify the previous solution (b) to introduce priorities in the writers. That is, if a thread is executing update_tree_safe, then the new incoming threads wait in order to perform the update operation.

NOTES:

- Include the declaration of the shared variables, condition variables and mutexes used in the solution.
- It is not necessary to write the main() function. It is only necessary to write the eval_investment_safe() and update_tree_safe() functions.

Exercise 4 (20 puntos).
Given a standard Linux (ext3) filesystem where the inodes have 10 direct pointers, one single indirect pointer, one double indirect pointer and one triple indirect pointer.

The disk size is 300MB, and the 96% space is available for data block. The rest of the disk space is used for the resto of the filesystem structures. The block size if 2KB and the block addresses are 32 bits.

Answer the following questions:

a- What is the maximum size (in KByters) that a file can use to store data without using the single double pointer.
b- What is the maximum file size (space used to store data)
c- Given a filesystem with the following information:

i-node table

I-node number	**1**	**2**	**3**	**4**	**5**	6	7
Type	Directory	Directory	File				
Physical link counter	3	2	1				
Data block address	11	12	13				
…….							

Data block

Block number	**11**	**12**	**13**	**14**	**15**	16	17	18
Content	**. 1**	**. 2**	File					
	.. 1	**.. 1**	data					
	d 2	**f1 3**						

Complete the following tables with the results of the execution of the following operations:

ln -s /d /d1 *Symbolic link from directory* /d1 to directory d

cp /d/f1 /f2 File copy from /d/f1 to /f2

mkdir /d/d2 Directory creation in /d/d2

Tables for exercise 4.c

i-node table

I-node number	**1**	**2**	**3**	**4**	**5**	6	7
Type	Directory	Directory	File				
Physical link counter	3	2	1				
Data block address	11	12	13				
…….							

Data block

Block number	**11**	**12**	**13**	**14**	**15**	16	17	18
Content	**. 1**	**. 2**	File					
	.. 1	**.. 1**	data					
	d 2	**f1 3**						