CSC 718 -- Operating System Design
Exam 1

Answer all the questions. The maximum credit for each question is as shown.

1. (14) For each of the following statements indicate whether it is true or false, and give a one-sentence justification.

    a. In a monolithic kernel, most operating system components, e.g., memory management, IPC (interprocess communication), and basic synchronization modules, execute outside the kernel.

    Ans: False
    Everything below the system call interface and above the physical hardware is the kernel. The kernel provides the file system, CPU scheduling, memory management, and other operating system functions through system calls.

    b. A process is a program.

    Ans: False
    A process is a program in execution.

    c. Suspending a process involves suspending all threads of the process since all threads share the same address space.

    Ans: True
    Suspending a process is to swap this process to disk to free up more memory. Since resources belong to the process, so if the process is suspended, all threads of the process will be suspended.

    d. In a multithreaded environment, the unit of resource ownership and scheduling/execution is thread.

    Ans: False
    In a multithreaded environment, the unit of resource ownership is process, the unit of scheduling/execution is thread.

    e. If one thread in a process is blocked, this prevents other threads in the process even if that other thread is in a ready state.

    Ans: False
    Depends on whether OS is involved when the thread is blocked. If OS is involved, then answer is “yes”.

f. Each thread of one process has to maintain a separate program counter, stack, and registers.

Ans: True
Thread control block contains a separate program counter, stack, and registers. These are necessary to keep the execution of the thread.

g. Round-robin scheduling never results in more context switches than FCFS.
Ans: False
It depends on the quantum. If every job has an execution time less than the quantum, then it has the same number as FCFS.

2. (16) What are the 4 hardware components of a computer system? Explain briefly each of these components.

Ans:
- Processor (CPU):
  - Control the operation of the computer and its data processing functions.
- Main Memory
  - Stores data and programs
  - RAM - random access memory
- I/O Modules
  - Auxiliary storage like disk drives, tape drives
  - Printers, terminals, monitors
- System Bus
  - Provides for transfer of data among processors, main memory, and I/O modules

3. (10) Briefly describe one advantage and one disadvantage of kernel-level threads.

Ans:
Advantages:
- The kernel can schedule another thread when if one thread performs a blocking system call, e.g., to do I/O.
- Multiprocessing is easier because the kernel can directly schedule threads.

Disadvantage:
- More Overhead
- The kernel is unaware of the user-level application parallelism. Even if multiple processors are given, the kernel may not fully utilize them.
- The kernel should be modified to support different thread package.

4. (10) What are the difference between interrupts and exceptions? Give two examples of each.

Ans:
Interrupts are asynchronous events external the CPU (e.g., timer interrupt, device interrupt).
Exceptions are synchronous events that occur as the result of executing instructions (e.g., divide by zero, system call).

5. (10) Explain what will be output for the following program?

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

int value = 5;

int main()
{
        pid_t pid;
        pid=fork();
        if(pid==0){
                printf("I am the child process. \n");
                value+=15;
        }
        else if (pid > 0) {
                wait (NULL);
                printf("I am the parent process, value=%d ", value);
                exit(0);
         }
}
```

Ans:
I am the child process.
I am the parent process, value=5

6. (40) Consider the following set of processes, with the length of the CPU burst given in milliseconds:

Process	Burst Times	Priority
P1	10	3
P2	1	1
P3	2	3
P4	1	4
P5	5	2

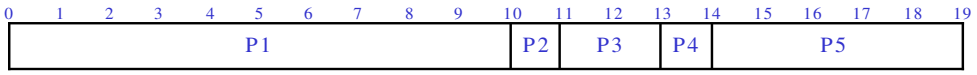
The processes are assumed to have arrived in the order P1, P2, P3, P4, P5, all at time 0.

a. (12) Draw four Gantt charts that illustrate the execution of these processes using the following scheduling algorithms: FCFS, SJF, nonpreemptive priority (a small priority number implies a higher priority), and RR(quantum=1).
b. (10) What is the turnaround time of each process for each of the scheduling algorithms in part a?
c. (10) What is the waiting time of each process for each of the scheduling algorithms in part a?
d. (8) Which of the algorithms in part a results in the minimum average waiting time (over all processes)?

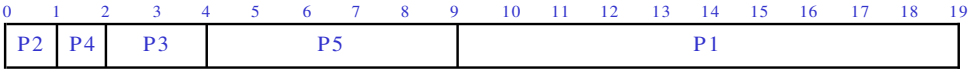
Ans:

a. The four Gantt charts are

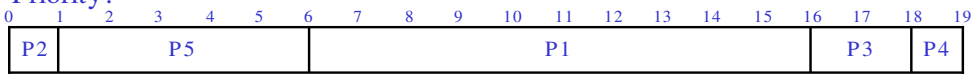
FCFS:



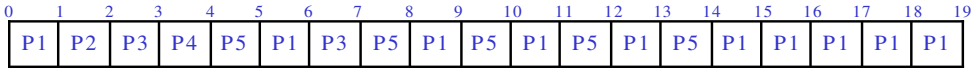
SJF:



Priority:



RR:



b. Turnaround time:

	FCFS	RR	SJF	Priority
P1	10	19	19	16
P2	11	2	1	1
P3	13	7	4	18
P4	14	4	2	19
P5	19	14	9	6

c. Waiting time (turnaround time minus burst time):

	FCFS	RR	SJF	Priority
P1	0	9	9	6
P2	10	1	0	0
P3	11	5	2	16
P4	13	3	1	18
P5	14	9	4	1

d. Shortest Job First