IT3072E Operating Systems, Spring 2022, Midterm exam [2]

Name: ______________________ Student ID: ______________________

Question 1: True/False(56pts, 3pts each)

1. Context switch of two user threads is run in the kernel space: **True**___ **False**___ true
2. The TCB of a user thread is stored in the user process: **True**___ **False**___ false
3. User thread system calls are initialized in the kernel space: **True**___ **False**___ false
4. User thread system calls are processed in the kernel space: **True**___ **False**___ true
5. Threads can create other threads using the command "pthread_create()": **True**___ **False**___ true
6. When a process creates a thread using the command "pthread_create()", this command returns the TID of the child thread to the process and return the TID of the parent to the newly created thread: **True**___ **False**___ false
7. In normal circumstances, two different threads can share the same runtime stack: **True**___ **False**___ false
8. The pthread_exit(0) command executed inside a thread will also cause the parent process to exit: **True**___ **False**___ false
9. The command getpid() returns the PID of the child process to the parent process: **True**___ **False**___ false
10. A parent process can execute the command waitpid() to wait for its child until it finishes: **True**___ **False**___ true
11. A thread in "running" state can transit to 3 different states: waiting, ready and terminated: **True**___ **False**___ false
12. A user thread that runs in kernel mode has the same scheduling priority as when it runs in user mode: **True**___ **False**___ true
13. Context switch means a process switching from a "blocked state" to "ready state": **True**___ **False**___ false
14. The scheduling algorithm that optimizes performance of interactive threads is FCFS scheduling: **True**___ **False**___ false
15. Context switch of two processes is heavier because data in the PCB of each process also need to be switched: **True**___ **False**___ true
16. Only threads are context-switched, but if the two threads in a context switch do not belong to the same process, then the process is context-switched as well: **True**___ **False**___ true
17. The root of a tree of processes is passed the ID of all the processes in the tree: **True**___ **False**___ false
18. There is at least two stacks in a process, one for the process and one for its thread component: **True**___ **False**___ false

Question 2: Processes (9pts)

```
pid_t = childpid;
int i;
childpid = fork();
pthread_create();
if (childpid == 0){
   for (i=1; i<2; i++){
      pthread_create();
   }
   fork();
}
fork();
```

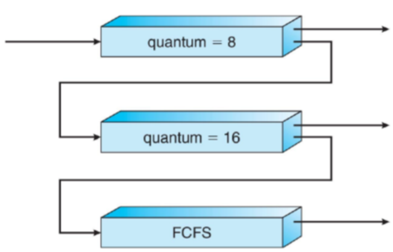
In the C code above, not including the original process, how many processes are created (in other words, how many fork() are executed): a) 5___; b) 4___; c) 3___; d) 6___ Solution: a

Question 3: Threads (9pts)

```
pid_t = childpid;
int i;
childpid = fork();
pthread_create();
if (childpid == 0){
   for (i=1; i<2; i++){
      fork();
      pthread_create();
   }
   pthread_create();
}
fork();
```

In the C code above, how many threads are created (in other words, how many pthread_create() are executed): a) 5___; b) 4___; c) 3___; d) 6 ___ Solution: d

Question 4: Scheduling (20pts)



Assume 4 processes P_0, P_1, P_2, and P_3 arrive in this order at time 0 in the ready queue of the multilevel feedback queue of the figure above.

1. The CPU burst time of each process is as follow: $P_0 = 24$, $P_1 = 32$, $P_2 = 24$, and $P_3 = 24$. What is the turnaround time of process P_0? a) 24___; b) 48___; c) 16___ Solution: b

2. The CPU burst time of each process is as follow: $P_0 = 36$, $P_1 = 28$, $P_2 = 24$, and $P_3 = 24$. What is the waiting time of process P_0 in the second queue? a) 28___; b) 16___; c) 24___ Solution: c

3. The CPU burst time of each process is as follow: $P_0 = 16$, $P_1 = 32$, $P_2 = 24$, and $P_3 = 24$. What is the waiting time of process P_0? a) 24___; b) 48___; c) 36___ Solution: a

4. The CPU burst time of each process is as follow: $P_0 = 32$, $P_1 = 8$, $P_2 = 28$, and $P_3 = 16$. What is the turnaround time of process P_3? a) 84___; b) 72___; c) 22___ Solution: b

5. The CPU burst time of each process is as follow: $P_0 = 16$, $P_1 = 12$, $P_2 = 28$, and $P_3 = 16$. What is the waiting time of process P_3 in the second queue (quantum = 16)? a) 28___; b) 16___; c) 52___ Solution: a

Question 5: Multilevel feedback queues scheduling (8pts)

The table below describes a 5 levels feedback queue similar to the Solaris feedback queue for time-sharing and interactive threads, where 0 is the lowest priority. In this table "Time quantum expired" is the new priority of a process that did not complete its current CPU burst in the allocated time quantum of the queue, while "Return from I/O" is the new priority of a process that enters an I/O phase before the end of the allocated time quantum of the queue.

Priority	Quantum time	Time quantum expired	Return from I/O
0	10	0	2
1	8	0	2
2	6	0	3
3	4	1	4
4	2	1	4

We have 3 processes P_0, P_1 and P_2 which have execution cycles as described below. For example, the arrival time of P_0 is 0, its first CPU burst last 5ms, then enters into an I/O queue for 3ms, then a CPU burst of 5ms, an I/O of 4ms, CPU burst of 4ms and then exit.

P_0	CPU	I/O	CPU	I/O	CPU	exit
0	5	3	5	4	4	

P_1	CPU	I/O	CPU	exit
1	8	4	4	

P_2	CPU	I/O	CPU	exit
2	2	6	2	

There is one CPU. The possible **states** of a process are the following: 1) ready to execute: "RY-x" where x is the priority queue in which the process is waiting; 2) running: "RU-x" where x is the priority queue in which the process was before been scheduled to run; 3) waiting in an I/O queue: "I/O-x" where x refers to the priority queue in which the process will be placed after completing its I/O; 4) exited: "EX"

All the processes start in priority queue 2. Arrival times of process P_0 is 0, process P_1 is 1 and process P_2 is 2. The scheduler always empty first the queue of higher priority before it starts to run processes in the next lower priority queue. The scheduler never preempts a currently running lower priority process. The tables below describe 3 possible scheduling for the first 20 ms, which one is correct considering the CPU bursts and I/O bursts of P_0, P_1 and P_2. Solution is b)

a)

	4	6	14	19
P_0	RU-2	I/O-3	RU-3	EX
P_1	RY-2	RY-2	RY-0	RY-0
P_2	RY-2	RU-2	RY-3	RU-3

b)

	4	6	14	19
P_0	RU-2	I/O-3	RU-3	I/O-3
P_1	RY-2	RU-2	RY-0	RY-0
P_2	RY-2	RY-2	RY-2	RU-2

c)

	4	6	14	19
P_0	RU-2	I/O-0	RY-0	RU-0
P_1	RY-2	RU-2	I/O-3	RY-3
P_2	RY-2	RY-2	RU-2	RU-2