ECE30021-02/ITP30002-02 Operating Systems, Spring 2019

Midterm Exam

Your Name and Student Number: _____

- You have **90 minutes** to answer to **7 problems** (100 points).
- Check you have total **5 pages** including this cover page.
- Write answers **only in given boxes**. Words outside the boxes will not be counted.
- Write answers **clearly**. No points for illegible writings.
- Read the following quoted from Handong CSEE Standard and write your signature below.

> Examination
>
> 1. Examination is an educational act necessary for evaluation of the students' achievement and for encouraging the students to absorb the material in the process of preparation.
> 2. Student should do their best to prepare for exams in order to improve her/his own knowledge and skill and should fully engage in the test during examination hour.
> 3. Accessing or providing unauthorized information, including other students' answer sheets, is regarded as cheating. The use of electronic devices, including cell phones and computers, without permission is strictly prohibited.
> 4. Entering or leaving the classroom during the examination before the finish time without permission is regarded as cheating.

I agree to uphold Handong Honor Code and Handong CSEE Standard in taking this exam.

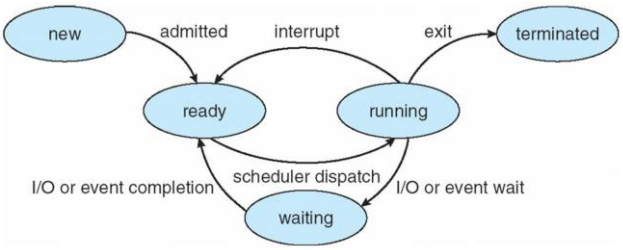
Signature: _____

1. Suppose that you have a system that runs multiple similar processes with the Round-Robin scheduling algorithm. And you want to find a chance to improve the throughput of the system for using Round-Robin.
   Explain how you can find this change and what kinds of actions you can possibly take for this system (10 points)

2. Suppose that your system has a special hardware module. To interface application programs with the hardware module, you are asked to add a new system call to the kernel. Explain what you need to add and/or modify to accomplish this task (18 points)

3. What are the advantages of using loadable kernel modules over monolithic kernel, over layered kernel, and over microkernel? (15 points)

4. Suppose that you want to implement an operating system that supports kernel-level threading with the Round-Robin scheduler, where which the status of a thread changes as below:



What kinds of hardware/architecture supports (i.e., components, features) are essential for enabling this operating system? (14 points)

5. Suppose that your program has a large array of integers in main memory, and you need to sort the elements in ascending order.

   The following is quick-sort code written in C:

```
int partition (int arr[], int low, int high) {
    int pivot = arr[high] ;
    int i = (low - 1) ;

    for (int j = low; j <= high- 1; j++) {
        if (arr[j] <= pivot) {
            i++;    // increment index of smaller element
            swap(&arr[i], &arr[j]);
        }
    }
    swap(&arr[i + 1], &arr[high]);
    return (i + 1);
}

void qsort(int arr[], int low, int high) {
    if (low < high) {
        int pi = partition(arr, low, high);
        qsort(arr, low, pi - 1);
        qsort(arr, pi + 1, high);
    }
}
```

   Write a function `qsort_pthread()`, a multithreaded version of `qsort()` with Pthread, in addition to the code above. Note that, for certain situations, `qsort_pthread()` would better to call `qsort()` for an efficiency reason (16 points).

6. Suppose that a system has N threads whose identifiers are assigned as 0 to N-1. The following code describes a general structure of these threads each of which has a critical section and its guarding entry and exit sections :

```
do {
    while (turn != _tid) ; /* entry section */
    /* critical section */
    turn = (_tid + 1) % N ; /* exit section */
    /* remainder section */
} while (true) ;
```

Discuss whether this code correctly protects the critical section, and what are the problems/limitations if exist (15 points).

7. The following table shows the arrival time, the computation time, and the deadline (i.e., time bound) of five tasks, T1 to T5,

Task name	Arrival time	Computation time	Deadline time
T1	0 msec	1 msec	2 msec
T2	0 msec	2 msec	5 msec
T3	2 msec	2 msec	4 msec
T4	3 msec	2 msec	10 msec
T5	6 msec	2 msec	9 msec

Describe how these tasks are scheduled by the Earliest-deadline-first scheduling algorithm for first 10 msec (12 points).