# 長庚大學114學年度第一學期 資工所博士班資格考試
## 科目：作業系統

1. (10%) Consider the following processes, assume that the time unit is one millisecond.
   (a) Draw the scheduling charts for non-preemptive SJF (Shortest Job First) scheduling and FCFS (first come first serve) scheduling. (5%)
   (b) Derive the average waiting time of each scheduling algorithm. (5%)

| Process | Burst Time (ms) | Ready Time (ms) |
|---|---|---|
| P1 | 4 | 0 |
| P2 | 6 | 1 |
| P3 | 2 | 4 |
| P4 | 1 | 2 |
| P5 | 1 | 5 |

2. (10%) Assume that the fork() function is always successful, please provide the output of the following program.

```
#include<sys/types.h>
#include<stdio.h>
#include<unistd.h>
int main()
{
    pid_t pid, pid2;
    pid = fork();
    if (pid == 0)
    {
        printf("1");
        pid2 = fork();
        if (pid2 == 0)
        {
            printf("2");
        }
        else
        {
            wait(NULL);
            printf("3");
        }
         printf("4");
    }
    else
    {
        wait(NULL);
        printf("5");
    }
    printf("6");
    return 0;
}
```

3. (20%) You are asked to explain the concept of virtual memory systems. Please answer the questions listed below.
   (a) With a virtual memory system, please provide the reason for that OS can run a program with its size exceeding the size of the main memory. (5%)
   (b) For a 32-bit virtual memory system with the 4K-Byte page size, please roughly explain the process for translating a virtual address to a physical address with a page table. (5%)
   (c) What is the purpose of TLB (Translation Look-aside Buffer)? (5%)
   (d) How can we use a page table with the TLB? (5%)

4. (10%) There is a system with only 3 memory frames. Given a reference string of pages {5→1→4→3→4→3→5→1→4→1→3}. Please illustrate the page replacement of (a) the LRU (Least Recently Used) algorithm (5%) and (b) the optimal algorithm. (5%) You should show the memory frames and the LRU queue for the LRU algorithm. The explanation for each page replacement of the optimal algorithm should be provided.

5. (10%) For the thrashing in operating systems, please answer the following questions:
   (a) What is the cause of thrashing? (2%)
   (b) How does an operating system detect thrashing? (5%)
   (c) Once the system detects thrashing, what can the system do to eliminate this problem? (3%)

6. (10%) Please define I/O-bound processes and CPU-bound processes.

7. (10%) There are three processes:
   $P_1$: a * b → a
   $P_2$: a + d → d
   $P_3$: e + d → d
   $P_1$ should run before $P_2$ does. The access to valuable "d" must be protected in a critical session. The order of $P_2$ and $P_3$ is arbitrary. We have two semaphores $S_1$ and $S_2$, and they are initialized as $S_1$=0 and $S_2$=1. Now, the code of $P_1$ is provided as follows:
   a = a * b;
   signal($S_1$);
   Please provide the code of $P_2$ and $P_3$.

8. (10%) Suppose that a disk drive has 5000 cylinders, numbered from 0 to 4999. The drive is currently serving a request at cylinder 1012, and the previous request was at cylinder 1006. The queue of pending requests, in FIFO order, is 86, 1458, 913, 1800, 948, 1509, 1022, 1750, 130. Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests, for each of the following disk scheduling algorithms? (a) SSTF (b) SCAN

9. (10%) Please provide the definitions of (a) multiprogramming (4%) and (b) time sharing (4%). (c) What is the problem if an OS has only multiprogramming technique without the time-sharing support? (2%)