長庚大學113學年度第二學期 資工所博士班資格考試
科目：作業系統

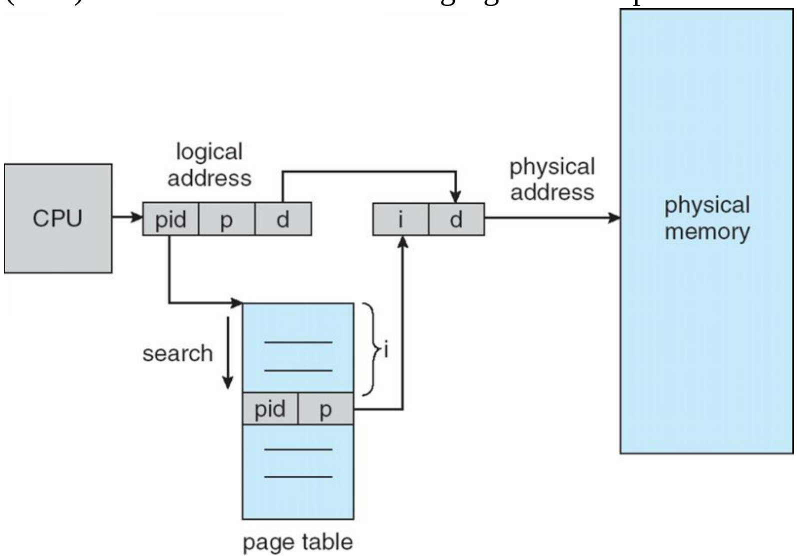
1. (10%) Consider the following processes, assume that the time unit is one millisecond.
   (1) Draw the scheduling charts for non-preemptive SJF (Shortest Job First) scheduling and FCFS (first come first serve) scheduling. (5 pts)
   (2) Derive the average waiting time of each scheduling algorithm.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

Process	Burst Time (ms)	Ready Time (ms)
P1	6	0
P2	8	1
P3	3	2
P4	1	3
P5	2	4

2. (10%) We assume that all the fork functions are successfully executed. 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("Hello\n");
        pid2 = fork();
        if (pid2 != 0)
        {
            wait(NULL);
            printf("Hi\n");
        }
        else
        {
            printf("Hola\n");
        }
    }
    else
    {
        wait(NULL);
        printf("Bonjour\n");
    }
    printf("Guten tag\n");
    return 0;
}
```

3. (10%) Please refer to the following figure and explain the inverted page table architecture



4. (10%) Let's consider the Readers and Writers Problem. We now have two mutex instances, mutex1 and mutex2. Please complete the code of writers and readers. (You should fill in all $\boxed{?}$ with mutex1 or mutex2 in the following sample code.)

<u>Writer:</u>

wait($\boxed{?}$);
… writing … ;
signal($\boxed{?}$);

<u>Reader:</u>

wait($\boxed{?}$);
readcount++;
if (readcount == 1) {wait($\boxed{?}$);}
signal($\boxed{?}$);
… reading … ;
wait($\boxed{?}$);
readcount--;
if (readcount== 0) {signal($\boxed{?}$);}
signal($\boxed{?}$);

5. (10%) There is a system with only 3 memory frames. Given a reference string of pages {7→1→4→3→4→3→5→1→4→1→3}. Please illustrate the page replacement of (1) the LRU (Least Recently Used) algorithm (5 pts) and (2) the optimal algorithm. (5 pts) 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.

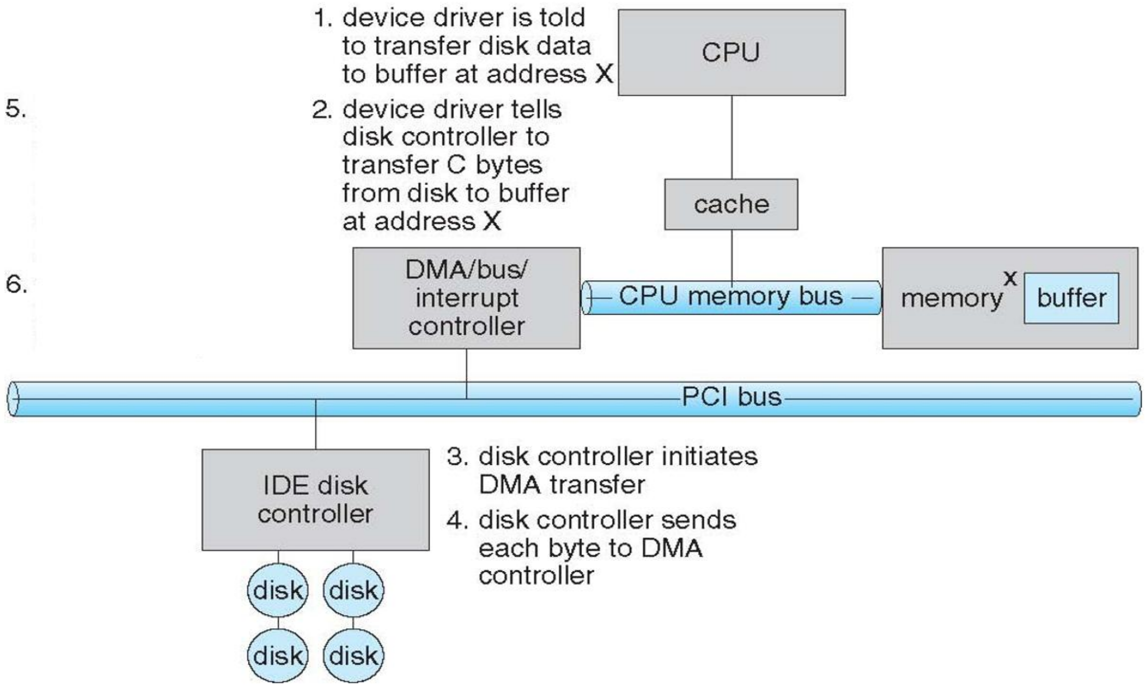
6. (10%) For the relationship between user threads and kernel threads, there are three models: Many-to-One, One-to-One, and Many-to-Many. Please explain the Many-to-Many model (5 pts) and the One-to-One model. (5 pts)

7. (10%) Please define I/O-bound processes and CPU-bound processes.

8. (10%) Banker's Algorithm is a deadlock avoidance algorithm. Assume there are 5 processes {P_0, P_1, P_2, P_3, P_4} and three types of shared resources {A, B, C} in the system, and the details are in the following table. (1) By Banker's Algorithm, is the system in a safe state? If your answer is yes, please provide a safe sequence. If your answer is no, please provide the reason. (5 pts) (2) Now, P_0 further has a request (2, 1 , 0) to use 2 more instances of A and 1 more instances of B. Should the request be granted? Again, provide the reason to support your answer. (5 pts)

	Allocation			Max			Need			Available		
	A	B	C	A	B	C	A	B	C	A	B	C
P0	0	1	0	7	5	3	7	4	3	3	3	2
P1	2	0	0	3	2	3	1	2	3			
P2	3	0	2	9	0	2	6	0	0			
P3	2	1	1	2	2	2	0	1	1			
P4	0	0	2	4	3	3	4	3	1			

9. (10%) I/O device management is a critical issue of operating systems. (a) What is the advantage for using Direct Memory Access (DMA)? (b) Please refer to the following figure to explain the details of DMA. Steps 1 to 4 are provided. You have to provide the contents of Steps 5 and 6.



10. (10%) Many operating systems provide the support of virtual memory. With virtual memory, we can further do demand paging to start a process without loading all data and binary of the program into the main memory. Now, please explain the problem if operating systems do not support virtual memory.