長庚大學113學年度第一學期 資工所博士班資格考試
科目：作業系統

1. (20%) Please explain the following terminologies:
   (1) Race condition (5 pts)
   (2) CPU-bound process (5 pts)
   (3) Direct memory access (5 pts)
   (4) Thrashing (for multiprogramming) (5 pts)

2. (12%) 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. (6 pts)
   (2) Derive the average waiting time of each scheduling algorithm. (6 pts)

Process	Burst Time (ms)	Ready Time (ms)
P1	3	0
P2	8	1
P3	7	2
P4	1	3
P5	3	4

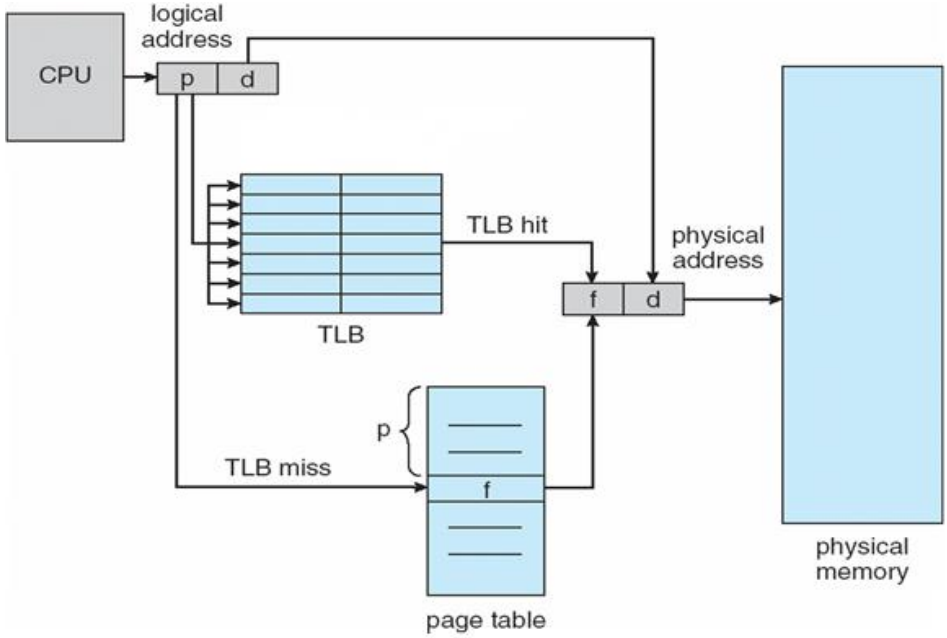
3. (10%) There is a system with only 3 memory frames. Given a reference string of pages {4→2→0→3→0→3→5→2→0→2→3}. Please illustrate the page replacement of (a) the LRU (Least Recently Used) algorithm (5 pts) and (b) the optimal algorithm. (5 pts) You should show the memory frames and the LRU queue for the LRU algorithm. The explanation for each page replacement of the optimal algorithm should be provided.

4. (12%) 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. (6 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. (6 pts)

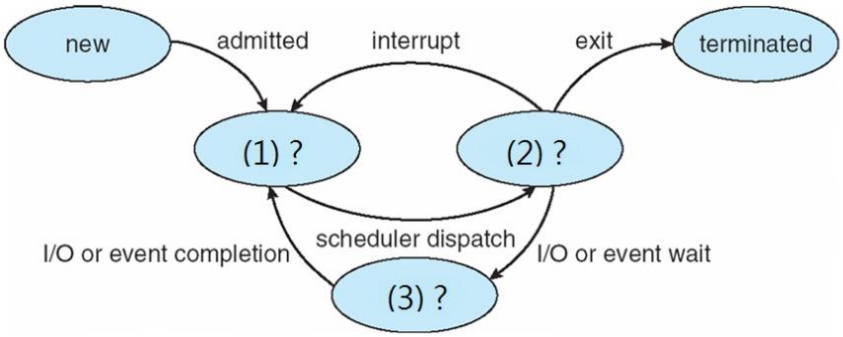
	Allocation			Max			Need			Available		
	A	B	C	A	B	C	A	B	C	A	B	C
P0	0	1	0	7	5	3	7	4	3	3	3	2
P1	2	0	0	3	2	3	1	2	3			
P2	3	0	2	9	0	2	6	0	0			
P3	2	1	1	2	2	2	0	1	1			
P4	0	0	2	4	3	3	4	3	1			

5. (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)

6. (12%) This question is to evaluate your knowledge of memory paging. For a system with a page table and a TLB (Translation Lookaside Buffer), as shown in the following figure, please (1) provide the definition of TLB. (6 pts) (2) Please explain the meaning of the numbers p, d and f in the figure. (6 pts)



7. (12%) The possible states of a process are ready, running, and waiting. Please indicate the states of (1), (2), and (3) of the following figure. (4 pts for each)



8. (12%) There are three processes:
   - P_1: a * b → a
   - P_2: b + c → c
   - P_3: c + d → d

   The access (including reading and writing) to valuables "b" and "c" must be protected in critical sessions. We now have two semaphores, and they are initialized as S_1=1 and S_2=1. The code of P_1 is provided as follows:

   wati(S_1);
   a = a * b;
   signal(S_1);

   Please provide the code of P_2 (6 pts) and P_3. (6 pts) There is no precedence constraint among the three processes.