105 學年度第 2 學期博士班資格考試

科目：作業系統

INSTRUCTIONS: *If any question is unclear or you believe some assumptions need to be made, state your assumptions clearly at the beginning of your answer.*

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1. (10%) What would be the output of the following C program? (*Note that the line numbers are for reference only.*)

```c
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <pthread.h>
#include <sys/types.h>
#include <sys/wait.h>
static void *runner(void *param)
{
    (* (int*) param)++;
    pthread_exit(0);
}
int main(int argc, char **argv)
{
    int value = 10;
    pid_t pid = fork();
    if (pid > 0) {
        int status;
        waitpid(-1, &status, 0);
        printf("A = %d\n", ++value);
    }
    else if (pid == 0) {
        pid_t pid = fork();
        if (pid > 0) {
            int status;
            waitpid(-1, &status, 0);
            printf("B = %d\n", value++);
        }
        else if (pid == 0) {
            pid_t pid = fork();
            pthread_t tid;
            pthread_create(&tid, NULL, runner, &value);
            pthread_join(tid, NULL);
            if (pid > 0) {
                int status;
                waitpid(-1, &status, 0);
                printf("C = %d\n", ++value);
            }
            else
                printf("D = %d\n", value++);
        }
        else
            return 1;
    }
    else
        return 1;
    return 0;
}
```

2. (10%; 5% each) Assume a page reference string for a process with m frames (initially all empty). The page reference string has length p with q distinct page numbers occurring in it. For any page-replacement algorithms,

   (a) What is an upper bound on the number of page faults? **Justify your answer for credit.**

   (b) What is a lower bound on the number of page faults? **Justify your answer for credit.**

3. Given a UNIX i-node with ten direct blocks and three levels of indirect blocks (i.e., a single, a double, and a triple) and assuming that the sizes of a pointer and a block are, respectively, 8 bytes and 8 Kbytes, answer the following questions.

   (a) (5%) What would be the size of the smallest file allowed in bytes?

   (b) (5%) What would be the size of the largest file allowed in bytes?

4. A disk has 16000 cylinders, each with 16 tracks of 512 blocks. A seek takes 1 ms per cylinder moved. If no attempt is made to put the blocks of a file close to each other, two blocks that are logically consecutive (i.e., follow one another in the file) will require an average seek, which takes 6 ms. If, however, the operating system makes an attempt to cluster related blocks, the mean interblock distance can be reduced to 2 cylinders and the seek time reduced to 200 μs. Assuming that the rotational latency is 3 ms and the transfer time is 10 μs per block, answer the following questions.

   (a) (5%) How long does it take to read a 300 block randomly placed file? **Justify your answer for credit.**

   (b) (5%) How long does it take to read a 300 block clustered file? **Justify your answer for credit.**

5. Consider the following page reference string:

   1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6.

   How many page faults would occur for the following replacement algorithms, assuming three, four, or five frames? Remember all frames are initially empty, so your first unique pages will all cost one fault each.

   (a) (5%) LRU replacement

   (b) (5%) Optimal replacement

6. (10%) A computer has 8 GB of RAM allocated in units of 4 KB. How many KB are needed if a bit map is used to keep track of free memory? **Justify your answer for credit.**

7. (10%) A computer whose processes have 2048 pages in their address spaces keeps its page tables in memory. The overhead required for reading a word from the page table is 600 nsec. To reduce this overhead, the computer has a TLB, which holds 32 (page, frame) pairs and can do a lookup in 100 nsec. What hit rate is needed to reduce the mean overhead to 200 nsec or less, *assuming that TLB is looked up first before the page table is read*? **Justify your answer for credit.**

8. Using the page mapping depicted below,
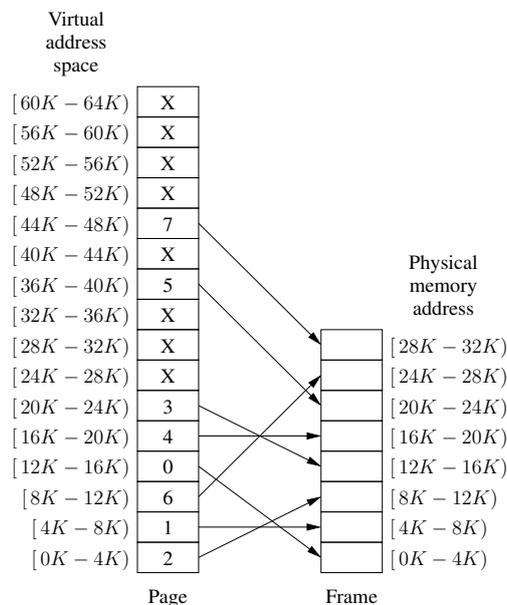
give the physical address corresponding to each of the following virtual addresses:

   (a) (5%) 4352

   (b) (5%) 8704

9. Suppose that a disk drive has 1000 cylinders, numbered from 0 to 999. The drive is currently serving a request at cylinder 200, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order, is

50, 500, 250, 800, 350, 550, 400, 600, 100.

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) (5%) SCAN

   (b) (5%) LOOK

10. (10%) A machine has 48-bit virtual addresses and 32-bit physical addresses. Pages are 4 KB. How many entries are needed for the page table? **Justify your answer for credit.**