國立中山大學資訊工程學系

９５學年度第１學期博士班資格考試　作業系統

1. 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 five, six, or seven frames? Remember all frames are initially empty, so your first unique pages will all cost one fault each.

   (a) (5%) LRU replacement

   (b) (5%) FIFO replacement

   (c) (5%) Optimal replacement

2. Measurements of a certain system have shown that the average process runs for a time T before blocking on I/O. A process switch requires a time S, which is effectively wasted (overhead). For round-robin scheduling with quantum Q, give a formula for the CPU efficiency (i.e., the useful CPU time divided by the total CPU time) for each of the following:

   (a) (3%) $Q = \infty$

   (b) (3%) $Q > T$

   (c) (3%) $S < Q < T$

   (d) (3%) $Q = S$

   (e) (3%) Q nearly 0

3. (10%) Consider the interprocess-communication scheme where mailboxes are used. Suppose a process P wants to wait for two messages, one from mailbox A and one from mailbox B. What sequence of `send` and `receive` should it execute so that the messages can be received in any order?

4. Suppose that a scheduler has k ready processes at time 0, and that no new processes are created after time 0. Process i ($0 < i \leq k$) requires i units of computing time. Answer each of the following questions.

   (a) (5%) For a preemptive, round-robin scheduler with a scheduling quantum of one time unit, what is the mean turnaround time for these processes, assuming that process k is at the front of the ready queue and that other processes appear in decreasing order of required computing time?

   (b) (5%) For a non-preemptive, shortest-job-first scheduler, what is the mean turnaround time for these processes?

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

   (a) (5%) What is a lower bound on the number of page faults? **For full credit, justify your answer.**

   (b) (5%) What is an upper bound on the number of page faults? **For full credit, justify your answer.**

6. Consider the two-dimensional array `A`:

   ```
   int A[][] = new int[100][100];
   ```

where each integer occupies 4 bytes and `A[0][0]` is at location 200, in a paged system with pages of size 200 bytes. A small process is in page 0 (locations 0 to 199) for manipulating the matrix; thus, every instruction fetch will be from page 0. For three page frames, how many page faults are generated by the following array initialization loops, using LRU replacement, and assuming page frame 1 has the process in it, and the other two are initially empty:

(a) (5%)

```
for (int i = 0; i < 100; i++)
    for (int j = 0; j < 100; j++)
        A[i][j] = 0;
```

(b) (5%)

```
for (int j = 0; j < 100; j++)
    for (int i = 0; i < 100; i++)
        A[i][j] = 0;
```

7. Consider a file currently consisting of 200 blocks. Assume that the file control block (and the index block, in the case of indexed allocation) is already in memory. Calculate how many disk I/O operations are required for contiguous, linked, and indexed (single-level) allocation strategies, if, for one block, the following conditions hold. In the contiguous allocation case, assume that there is no room to grow in the beginning, but there is room to grow in the end. Assume that the block information to be added is stored in memory.

   (a) (3%) The block is added at the beginning.

   (b) (3%) The block is added in the middle.

   (c) (3%) The block is added at the end.

   (d) (3%) The block is removed from the beginning.

   (e) (3%) The block is removed from the end.

8. 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) (3%) FCFS

   (b) (3%) SCAN

   (c) (3%) LOOK

   (d) (3%) C-SCAN

   (e) (3%) C-LOOK