Operating Systems, Spring 2010

Final

2:10pm $\sim$ 3:50pm, Tuesday, June 22, 2010

INSTRUCTIONS:

1. This is a *closed-book* exam.
2. Try to solve all of the problems.
3. Try to give short answers. (Hint: An answer need not always be longer than the question.)
4. No cheating.
5. Please hand in both the exam sheet and the answer sheet.
6. Please note that unless otherwise stated, all the line numbers for the program listings are for reference only.

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1. (20%) Consider the two-dimensional array `A`:

   ```
   int A[][] = new int[200][200];
   ```

   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 (1) page frame 0 has the process in it, (2) the other two are initially empty, and (3) the array is stored in memory column-major.

   (a)
   ```
   for (int i = 0; i < 200; i++)
       for (int j = 0; j < 200; j++)
           A[i][j] = 0;
   ```

   (b)
   ```
   for (int j = 0; j < 200; j++)
       for (int i = 0; i < 200; i++)
           A[i][j] = 0;
   ```

2. (20%) A disk has 8000 cylinders, each with 8 tracks of 512 blocks. A seek takes 1 msec 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 5 msec. 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 100 microsec. How long does it take to read a 100 block file in both cases, if the rotational latency is 10 msec and the transfer time is 20 microsec per block?

3. (20%) Given an i-node with eight direct blocks and three levels of indirect blocks and assuming that the sizes of a pointer and a block are, respectively, 8 bytes and 8 Kbytes, answer the following questions. *(Hint: you may assume all the meta-information for a file has been read into the main memory and forget about the case where some buffers may need to be written back to disk first.)*

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

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

4. (20%) A small computer has four page frames. At the first clock tick, the R bits are 0111 (page 0 is 0, the rest are 1). At subsequent clock ticks, the values are 1011, 1010, 1101, 0010, 1010, 1100, 0001, 0101, 1011, and 1111. If the aging algorithm is used with an 8-bit counter, give the values of the four counters after the last ticks.

5. (20%) A computer has four page frames. The time of loading, time of last access, and the R and M bits for each page are as shown below (the times are in clock ticks):

Page	Loaded	Last Reference	R	M
0	126	279	0	0
1	230	260	1	0
2	120	272	1	1
3	160	280	1	1

(a) Which page will FIFO replace?

(b) Which page will LRU replace?

(c) Which page will NRU replace?

(d) Which page will second chance replace?