CS4SH3 Test 1 Winter 2002

Name _____ Student No. _____

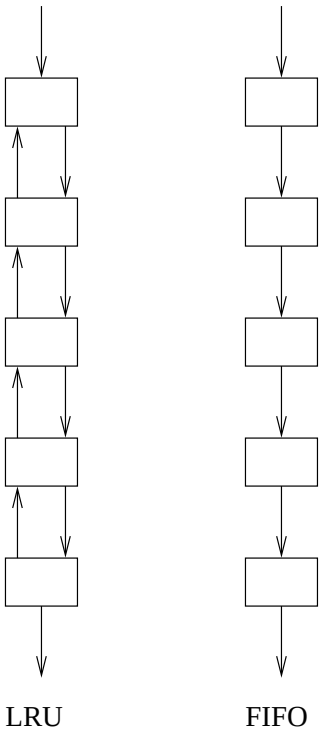
No aids allowed. Answer all questions on test paper. Use backs of sheets for scratch work.

Total Marks: 30

[10] 1. Consider the following sequence of requests:

$$1, 2, 3, 4, 5, 4, 6, 6, 2, 1, 5, 4, 3, 2, 1$$

Fill in the following two lists, with the contents of the cache, after the entire sequence of requests has been processed. The left doubly-linked list corresponds to the LRU page replacing algorithm; the right list corresponds to the FIFO page replacing algorithm.



How many faults were incurred with LRU? How many with FIFO?

2. Let k, i be positive integers, and let $\sigma_{k,i}$ be a sequence of requests consisting of i segments of the form: $1, 2, 3, \ldots, k, k+1$. For example, if $k = 2$ and $i = 4$, then:

$$\sigma_{2,4} = \underbrace{1,2,3}_{1}, \underbrace{1,2,3}_{2}, \underbrace{1,2,3}_{3}, \underbrace{1,2,3}_{4}$$

Assume that we have a cache of size k.

[3] (a) How many page faults does the FIFO page-replacing algorithm incur on $\sigma_{k,i}$? Explain briefly.

[3] (b) How many page faults does the OPT page-replacing algorithm incur on $\sigma_{k,i}$? Explain briefly.

[4] (c) Is it possible for FIFO to be 2-competitive? Explain.

[10] 3. The Linux OS disk paging policy implements a "Least-Frequently-Used" (LFU) replacing policy. That is, a page is evicted from the cache if it is the least frequently used page in the cache.

Give an *explicit* implementation of this algorithm. (Hint: associate an age counter with each page in the cache; show how to update the ages on a hit and on a fault.)