

**True/False:**

- a. LRU caches are more complex than random caches.
  
- b. The optimal page replacement strategy is to evict the page which will be accessed least frequently on average.
  
- c. Write-through caching is better when a small number of items are modified frequently.

**Short Answer:**

In class we described 4 types of cache misses. Name and describe two of the types we discussed.

Below is a pseudo-code for the clock page replacement algorithm (we are assuming the clock is entirely "full" with pages, and a new page must be found). Fill in the blank:

```
replaced = false;
while (!replaced) {
  1.

  2. Advance clock hand

}
```

**Longer Answer:**

Caching: Assume a computer system employing a cache, where the access time to the main memory is 100 ns, and the access time to the cache is 20ns.

- a. (2 points) Assume the cache hit rate is 95%. What is the average access time?

b. (2 points) Assume the system implements virtual memory using a two-level page table with no TLB, and assume the CPU loads a word X from main memory. Assume the cache hit rate for the page entries as well as for the data in memory is 95%. What is the average time it takes to load X?

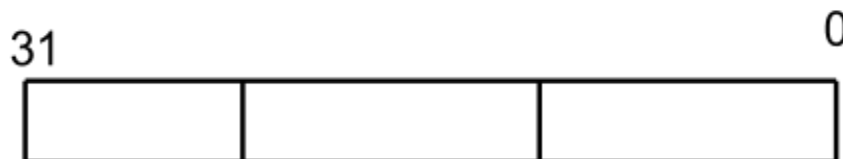
**Longest Answer (From Fall 2012 Midterm):**

Assume a system with a two level page table. The virtual memory address space is 32 bits and the physical memory address space is 16 bits.

a. Make sure that each translation table fits in a page.

i. What is the optimal page size?

ii. Specify the length of each field in the virtual address.



b. Assume you add to your system a 4-way set-associative data cache with 16 total cache blocks. Each block in the cache holds 8 bytes of data. In order to address a specific byte of data, you will have to split the address into the cache tag, cache index and byte select. Assume there are no modifiers bits in the table.

i. How many bits are used for byte selection?

ii. How many bits are used for the cache index?

iii. How many bits are used for the cache tag?