1. (10 points) 9.23 When a CPU writes to the cache, both the item in the cache and the corresponding item in the memory must be updated. If data is not in the cache, it must be fetched from memory and loaded in the cache. If t_1 is the time taken to reload the cache on a miss, show that the effective average access time of the memory system is given by
$t_{ave} = ht_c + (1-h)t_m + (1-h)t_1$

   • Assuming the cache does not have to be reloaded, the average access time is equal to
   $t_{ave} = ht_c + (1-h)t_m$
   In this case, the cache does take time to reload. For a single access, the time taken to reload the cache must be added to the no-miss access time. Since we are concerned about the average time, the cache reload time multiplied by the cache miss ratio must be added to the prior equation. This gives us
   $t_{ave} = ht_c + (1-h)t_m + (1-h)t_1$
   which is the hit ratio multiplied by the cache access time plus the miss ratio multiplied the memory access time plus the miss ratio multiplied by cache reload time.

2. (10 points) 9.26

3. (10 points) 9.35

4. (10 points) Assume a 64-bit virtual address and a 64-bit physical address. The page size is 4KB. How many total entries are there in the page table? Express your answer in powers of 2.

5. (10 points) 7.16

6. (10 points) 9.12

7. (10 points) 7.18

8. (10 points) 6.13

9. (15 points) 7.35

10. (15 points) 7.38