Assignment 4

Due November 8, 14:59

NOTE: Late submissions will **NOT** be accepted. Please put your solutions in the CENG 355 **drop-box** (ELW, second floor) – they will be collected at **15:00**.

1. [10 points] Assume a byte-addressable computer has 4-KB main memory and 128-byte cache with **eight blocks**, where each block has **four 32-bit words**. While executing some program, the CPU reads 32-bit words from the following sequence of 10 addresses:

088 22C 208 448 440 200 220 444 448 080

Show the cache contents (e.g., **[000]** = contents stored at address **000**) at the end of this sequence and calculate the corresponding miss rate given that:

(a) Cache is direct-mapped.
(b) Cache is 2-way set-associative (2 blocks per set) with LRU replacement.
(c) Cache is fully-associative with LRU replacement.

2. [10 points] Assume a byte-addressable computer has 4-KB main memory and 128-byte cache with **four blocks**, where each block has **eight 32-bit words**. While executing some program, the CPU reads 32-bit words from the following sequence of 10 addresses (in hexadecimal format):

088 090 250 09C 240 200 220 210 230 080

Show the cache contents (e.g., **[000]** = contents stored at address **000**) at the end of this sequence and calculate the corresponding miss rate given that:

(a) Cache is direct-mapped.
(b) Cache is 2-way set-associative (2 blocks per set) with LRU replacement.
(c) Cache is fully-associative with LRU replacement.

3. [5 points] Assume a computer uses L1 and L2 caches for both instructions and data. The L1 access time is $\mathbf{C_1 = 1\tau}$ (L1 hit), the L2 access time is $\mathbf{C_2 = 8\tau}$ (L1 miss, L2 hit), and the main memory access time is $\mathbf{M = 32\tau}$ (L2 miss). Assume that for some given application the L1 hit rate is $\mathbf{h_1 = 80\%}$ (for both instructions and data). What is the minimum possible value of the average access time $\mathbf{T_{ave}}$ under these assumptions? What is the L2 hit rate $\mathbf{h_2}$ (for both instructions and data) such that $\mathbf{T_{ave} = 4\tau}$?