

CS3810 Assignment 09

Question 1:

$$CPI = 1$$

If load Instruction is 1-cycle L_1 cache which means:

The cycle taken by L_1 in case of hit is = 1

$$\text{hit rate for } L_1 = 0.95$$

The cycle taken by L_2 in case of hit is = 10

$$\text{hit rate for } L_2 = 0.98$$

The cycle taken by L_3 in case of hit is = 20

$$\text{hit rate for } L_3 = 0.99$$

Penalty for L_1 cache miss, L_2 miss, L_3 miss / memory access time = 300 cycles

Percentage of Load Instruction = 30%

Rest of instructions = 70%

$$\begin{aligned} \therefore CPI &= L_1 \text{ cache hit probability} \times \text{Time} + L_1 \text{ miss probability} \times \text{memory Access time} \\ &= 0.9 \times 1 + 0.1 \times (0.98 \times (1+10)) + 0.02 \times (0.99 \times (1+10+20) + 0.01 \times (1+10+20+300)) \\ &= 2.046 \end{aligned}$$

Question 2:

Direct mapped Cache: $I = J \bmod M$

I is the cache block location, J is the memory address

M is the number of sets in cache = 8

1. $0 \bmod 8 = 0$ Hit

2. $48 \bmod 8 = 0$ As 0 Set is already occupied by 0 address of memory, so it's

3. $84 \bmod 8 = 4$ Hit

4. $32 \bmod 8 = 0$ Miss

5. $96 \bmod 8 = 0$ Miss

6. $360 \bmod 8 = 0$ Miss

7. $560 \bmod 8 = 0$ Miss

8. $48 \bmod 8 = 0$ Miss

9. ~~84~~ $84 \bmod 8 = 4$ Miss

10. $600 \bmod 8 = 0$ Miss

11. $84 \bmod 8 = 0$ Miss

12. $48 \bmod 8 = 0$ Miss

Total # of misses in cache is 10.

Question 3:

$$\text{Cache Size} = 128 \text{ kB} = 2^{7+10} \text{ Bytes} = 2^{17} \text{ Bytes}$$

$$\text{Block Size} = 64 \text{ B}$$

$$\# \text{ of Blocks in Cache} = \frac{2^{17} \text{ B}}{2^6 \text{ B}} = 2^9 \text{ Blocks}$$

$$\# \text{ of sets} = \frac{2^9 \text{ Blocks}}{4} = 2^9$$

$$\text{Index Tag Size} = 9$$

$$\# \text{ Blocks of set} = 64 = 2^6 = 6 \text{ bits}$$

$$\text{Tag Size} = (32 - (9 + 6)) = 32 - 15 = 17 \text{ bits}$$

$$\text{Tag Size} = 17 \text{ bits}$$

$$\therefore \begin{array}{|c|c|c|} \hline 17 & 9 & 6 \\ \hline \end{array}$$

Tag Index Blocks of set