5.3. (1, 2, 4, 5)
5.5. (1, 2)
5.6. (2, 4)

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CSM151B

CSM151B - HW #7

(5.3.1) Block size $\Rightarrow 2^5 = 32$ bytes

$= \left(\frac{32 \text{ bytes}}{1 \text{ block}}\right)\left(\frac{1 \text{ word}}{4 \text{ bytes}}\right) = \boxed{\frac{8 \text{ words}}{\text{block}}}$

(5.3.2) 5 index bits $\Rightarrow 2^5 = \boxed{32 \text{ entries}}$

(5.3.4)

Address	Bit Representation	Tag	Index	offset	Hit/Miss	Replaced
0	0 ... 0	0	00000	00000	M	N
4	0 ... 100	0	00000	00100	H	N
16	0 ... 10000	0	00000	10000	H	N
132	0 ... 010000100	0	00100	00100	M	N
232	0 ... 011101000	0	00111	01000	M	N
160	0 ... 010100000	0	00101	00000	M	N
1024	0 ... 10000000000	1	00000	00000	M	Y
30	0 ... 11110	0	00000	11110	M	Y
140	0 ... 010001100	0	00100	01100	H	N
3100	0 ... 011000011100	11	00000	11100	M	Y
180	0 ... 010110100	0	00101	10100	H	N
2180	0 ... 010000100000	10	00100	00000	M	Y

4 blocks replaced

(5.3.5) Hit rate = $4/12 = \boxed{\frac{1}{3}}$

(5.5.1) Block Count = $\left[\frac{(64)(1024) \text{ bytes}}{1}\right]\left(\frac{1 \text{ block}}{32 \text{ bytes}}\right) = 2048$ blocks

- Based on the pattern $\Rightarrow$ 16 accesses span a single block
- Due to the sequence $\Rightarrow$ there will be 1 miss for the first access of each block

Miss rate = $\frac{1}{16}$

- **Compulsory miss** due to the block not being in the cache upon being accessed for the first time
- Miss rate is sensitive to the size of the cache (i.e. how many blocks the cache can hold) as well as the sequence that data is to be accessed

(5.5.2) 16-byte block => 8 accesses span a single block

- compulsory miss per => 1/8

64-byte => 32 => 1/32

128-byte => 64 => 1/64

(5.6.2) AMAT = Hit time + (miss rate)(miss penalty)

(P1) => L1 miss rate = 8%, hit time = 0.66 ns

$AMAT_{P1} = 0.66 + (0.08)(70) = 6.26$

(P2) => = 6%, = 0.9 ns

$AMAT_{P2} = 0.9 + (0.06)(70) = 5.1$

(5.6.4) $AMAT = 0.66 + (0.06)[5.62 + (0.95)(70)] = 6.47$ Worse

(a) $AMAT = 1 + (0.3)[10 + (0.2)(80)] = 8.8$

(b) TCPI = BCPI + MCPI

BCPI = Perf CPI + P-t Haz + Ctrl Haz

$= 1.0 + (0.2)(0.6)(1) + (0.3)(0.5)(1) = 1.27$

MCPI = D$ + I$

$= (0.2)(0.3)[10 + (0.2)(80)] + (1)(0.1)[10 + (0.2)(80)] = 4.16$

$TCPI = 1.27 + 4.16 = 5.43$

(c) $(1 \times 10^6)(0.3)(2/3) = 200{,}000$ [branch]

$(1 \times 10^6)(0.2) = 200{,}000$ [loads]

$(1 \times 10^6)(0.5) = 500{,}000$ [R-type]

=> 2/9 => 2/9

$0.003 > -0.001 + 0.017 I_{MR}$

$I_{MR} < 0.167$

- Before 300,000 of instrs = branches, 50% taken = 150,000
- As prior = 1/6 of branches removed => $(\frac{1}{6})(300{,}000) = 50{,}000$ always taken
- New branch miss rate = $\frac{50{,}000}{200{,}000} = 25\%$

I_{MR} = I$ miss rate

$BCPI = 1.0 + (\frac{2}{9})(0.6)(1) + (\frac{2}{9})(0.2)(1) = 1.19$

$MCPI = (\frac{2}{9})(0.3)[10 + (0.2)(80)] + [I\$_{MR}][10 + (0.2)(80)]$

$= 1.73 + (26)(I_{MR})$

$TCPI = 2.92 + (26)(I_{MR})$

$ET_{old} = [IC][CPI][CT]$

$= (1 \times 10^6)(5.43)(0.5 \times 10^{-9}) = 0.003$

$ET_{new} = [(0.9)(1 \times 10^6)][2.92 + (26)(I_{MR})][0.5 \times 10^{-9}]$

$= 0.001 + 0.017(I_{MR})$