ISTANBUL TECHNICAL UNIVERSITY

COMPUTER ENGINEERING DEPARTMENT

BLG 322E

COMPUTER ARCHITECTURE
ASSIGNMENT 5

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Question 1

Part a)

Main Memory: 1 MiB = 2^{20} bytes

Cache Memory: 4 KiB = 2^{12} bytes

Address length = 20 bits

Word = 1 byte

Block = 16 words = 16 bytes

$\frac{1\text{MiB}}{16\text{B}} = 2^{16}$ blocks in total

Frame = 16 words = 16 bytes

$\frac{4\text{KiB}}{16\text{B}} = 2^8 = 256$ frames in total

$2^7 = 128$ sets since there are 2 frames in each set

Tag = 20 - 7 - 4 = 9

TAG	SET	WORD
9	7	4

A: \$0182F ⇒ 0000 0001 1000 0010 1111

Tag = 0000 0001 1 = 3

Set = 000 0010 = 2 (only 1st word for others Set = 3)

Word = 1111 = 15 (only 1st word for others ranges from 0000 to 1000)

B: \$0382F ⇒ 0000 0011 1000 0010 1111

Tag = 0000 0011 1 = 7

Set = 000 0010 = 2 (only 1st word for others Set = 3)

Word = 1111 = 15 (only 1st word for others ranges from 0000 to 1000)

C: \$07827 ⇒ 0000 0111 1000 0010 0111

Tag = 0000 0111 1 = 15

Set = 1000 0010 = 2 (for first 9 words for the final word Set = 3)

Word = ranges from (0111 to 1111 for first 9 words for the final word Word = 0000)

Part b)

There are 34 read hits and 6 read misses. Explanation:
1st iteration:

READ A –> MISS
SET 2 FRAME 0 –> A[0]
READ B –> MISS
SET 2 FRAME 1 –> B[0]
READ A –> HIT
READ C –> MISS
SET 2 FRAME 0 –> C[0−8]

2nd iteration:

READ A –> MISS
SET 3 FRAME 0 –> A[1−9]
READ B –> MISS
SET 3 FRAME 1 –> B[1−9]
READ A –> HIT
READ C –> HIT

Other 7 iterations

READ A –> HIT
READ B –> HIT
READ A –> HIT
READ C –> HIT

Final iteration

READ A –> HIT
READ B –> HIT
READ A –> HIT
READ C –> MISS
SET 3 FRAME 0 –> C[9]

Question 2

Part a)

Main memory: 1MiB = 2^{20}

Cache memory: 4 KiB = 2^8

Block size: 16 bytes

$\frac{1\text{MiB}}{16\text{B}} = 2^{16}$ blocks in total

$\frac{4\text{KiB}}{16\text{B}} = 2^8 = 256$ frames in total = 256 frames, f = 8

Address: a = 20 bits w = 4 bits main memory contains 2^{16} blocks, b = 16

Tag = 8 Frame = 8 Word = 4

TAG	FRAME	WORD
8	8	4

A: \$0182F ⇒ 0000 0001 1000 0010 1111

Tag = 0000 0001 = 1

Frame = 1000 0010 = 130 (only 1st word for others Frame = 131)

Word = 1111 = 15 (only 1st word for others ranges from 0000 to 1000)

B: \$0382F ⇒ 0000 0011 1000 0010 1111

Tag = 0000 0011 = 3

Frame = 1000 0010 = 130 (only 1st word for others Frame = 131)

Word = 1111 = 15 (only 1st word for others ranges from 0000 to 1000)

C: \$07827 ⇒ 0000 0111 1000 0010 0111

Tag = 0000 0111 = 7

Frame = 1000 0010 = 130 (for first 9 words for the final word Frame = 131)

Word = ranges from (0111 to 1111 for the first 9 words for the final word Word = 0000)

Part b)

There are 16 read hits and 24 read misses. Explanation:

1st iteration

READ A –> MISS
FRAME NUMBER: 130 –> a[0]
READ B –> MISS
FRAME NUMBER: 130 –> b[0]
READ A –> MISS
FRAME NUMBER: 130 –> a[0]
READ C –> MISS
FRAME NUMBER: 130 –> c[0−8]

2nd iteration

READ A –> MISS
FRAME NUMBER: 131 –> a[1−8]
READ B –> MISS
FRAME NUMBER: 131 –> b[1−8]
READ A –> MISS
FRAME NUMBER: 131 –> a[1−8]
READ C –> HIT

Other 7 iterations

READ A –> HIT
READ B –> MISS
FRAME NUMBER: 131 –> b[1−8]
READ A –> MISS
FRAME NUMBER: 131 –> a[1−8]
READ C –> HIT

Final iteration

READ A –> HIT
READ B –> MISS
FRAME NUMBER: 131 –> b[1−8]
READ A –> MISS
FRAME NUMBER: 131 –> a[1−8]
READ C –> MISS
FRAME NUMBER: 131 –> c[9]