Homework 10

1.a The cache block in cache is 4 bits for each.
The 4 bits offset the cache can have blocks of 24 bytes.
direct mapped cache = 16 bytes block size
four-way set = 16 bytes

b. 16 - Cache size = (block size in bytes) . (Blocks per set) (number of sets)
- block size = 16 bytes
- number of cache line = $\frac{\text{Cache size}}{\text{block size}}$

Index = 4 bits
$2^4 = 16$ sets

Index = $\frac{16}{4} = 4$ bytes

sets = $\frac{\text{number of lines}}{\text{set associativity}}$ =

Direct $\frac{16}{1}$ = 16 sets

associative $\frac{16}{2}$ = 8 sets

4-way $\frac{16}{4}$ = 4 sets

or

c.

d. 16 : 16 = 256 bytes
32 - 4 - 4 = 24 bits
16 . 256 = 4096
4 way = 1 bit

Direct = 256 B and 52 bytes metadata
two-way = 512 B and 104 Bytes metadata
4-way = 1024 B and 208 B metadata

d.

Memory access	Direct mapped	4-way set associative
0x100FEA0	Miss (invalid)	Miss (4x invalid)
0x100EFA4	Miss (tag mismatch)	Miss (tag mismatch) 3x invalid
0x100FBA8	Miss (tag mismatch)	Hit (way 0)
0x100C0A0	Miss (tag mismatch	Miss (2x tag mismatch, 2x invalid)
0x100C0B0	Miss (invalid)	Miss (4x invalid)
0x100C0C0	Miss (invalid)	Miss (4x invalid)
0x100IFA1	Miss (tag mismatch)	Miss (3x tag mismatch, 1x invalid
0x100EBA2	Miss (tag mismatch)	Miss (4x tag mismatch)
0x100EFAF	Miss (tag mismatch)	Miss (4x tag mismatch)
0x100C0A2	Miss (tag mismatch)	Hit (way 2)

N2 note =

Direct mapped

<Set A, way 0, 0x100100>
<set B, way 0, 0x100100>
<set C, way 0, 0x100100>

4 way set associative :

<set A, way 0; 0x100EF>
<set A, way 1; 0x100EE>
<set A, way 2, 0x100100>
<set A, way 3, 0x100IF>
<Set B, way 0; 0x100100>
<set C, way 0, 0x100100>

2. Exam question:

You have a 4-way set associative cache which has a total of 4096 bytes and a cache line of 128 bytes?

a) What's the total block size?

b) What's the number of cache lines?

c) Number of sets in cache?

d) What is the word offset (in bits)?

e) What is the set offset (in bits)?

Answer(s):

a) 128 bytes

b) $4096 / 128 = 32$ lines

c) $\frac{32}{4} = 8$ sets

d) $\log_2 8 = 3$ bits

e) $\log_2 128 = 7$ bits