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1.1)

Hamming (15, 11) for 1010 1001 010 is 0111 0101 1001 010

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	p
p1	p2	d1	p4	d2	d3	d4	p8	d5	d6	d7	d8	d9	d10	d11	
		1		0	1	0		1	0	0	1	0	1	0	
		1		0		0		1		0		0		0	0
		1			1	0			0	0			1	0	1
				0	1	0					1	0	1	0	1
								1	0	0	1	0	1	0	1
0	1	1	1	0	1	0	1	1	0	0	1	0	1	0	

*p = xor of the entire row, p column = p1, p2, p4, p8 (top to down)

Hamming (15, 11) for 1010 1101 010 is 0011 0100 1101 010

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	p
p1	p2	d1	p4	d2	d3	d4	p8	d5	d6	d7	d8	d9	d10	d11	
		1		0	1	0		1	1	0	1	0	1	0	
		1		0		0		1		0		0		0	0
		1			1	0			1	0			1	0	0
				0	1	0					1	0	1	0	1
								1	1	0	1	0	1	0	0
0	0	1	1	0	1	0	0	1	1	0	1	0	1	0	

*p = xor of the entire row, p column = p1, p2, p4, p8 (top to down)

1.2)

The hamming distance is 3

0	1	1	1	0	1	0	1	1	0	0	1	0	1	0
0	0	1	1	0	1	0	0	1	1	0	1	0	1	0

1.3)
Hamming (15, 11) 1111 1111 1111 110

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	p
p1	p2	d1	p4	d2	d3	d4	p8	d5	d6	d7	d8	d9	d10	d11	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
		1		1		1		1		1		1		0	0
		1			1	1			1	1			1	0	0
				1	1	1					1	1	1	0	0
								1	1	1	1	1	1	0	0

1 + 2 + 4 + 8 = 15
d11 is the wrong bit, should be 1

1.4)
Hamming (15, 11) 0000 0000 1000 000

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	p
p1	p2	d1	p4	d2	d3	d4	p8	d5	d6	d7	d8	d9	d10	d11	
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
		0		0		0		1		0		0		0	1
		0			0	0			0	0			0	0	0
				0	0	0					0	0	0	0	0
								1	0	0	0	0	0	0	1

1 + 8 = 9
d5 = wrong bit, should be 0

2.1)
48 bits virtual address
64GB = 2^36 bytes – 36 bits physical address
8kb = 2^13 bytes
13 bits = page frame numbers = Y
36 - 13 = 23 bits = offset within page = X
48 - 36 = 12 bits unused

X = 23 bits

2.2) Y = 13 bits

2.3)
0x7E9C3A5F4B6D = 0111 1110 1001 1100 0011 1010 0101 1111 0100 1011 0110 1101
X = 101 1111 0100 1011 0110 1101 = 5F4B6D = offset
Y = 1100 0011 1010 0 = 1874 = page frame

3.1)
10 page faults
2, 1, 3, 4, 2, 1, 3, 2, 6, 1, 3, 2, 1, 5, 3, 2, 1, 4

3 faults

	3	1	2

1 fault

4	3	1	2

1 fault

4	6	1	2

1 fault

4	6	3	2

1 fault

4	6	3	1

1 fault

5	6	3	1

1 fault

5	2	3	1

1 fault

5	2	4	1

3 + 1 + 1 + 1 + 1 + 1 + 1 + 1 = 10 faults

3.2)
keep the least used references stored for last
2, 1, 3, 4, 2, 1, 3, 2, 1, 3, 2, 1, 3, 2, 1, 4, [6, 5]

* 6 and 5 are stored for last

3 faults

	3	1	2

1 fault

4	3	1	2

1 fault

4	6	1	2

1 fault

4	6	5	2

The minimum page faults would be 6

4.4)

step	time	probability
4.1	0	0
4.1.1	0	0.9
4.1.2	X	0.09
4.1.3	0	0.01
4.2	0	0
4.2.1	Y	0.98
4.2.2	Z	0.02
4.2.3	0	0
4.3	0	0.0001
4.4	V	0

(0.9+0.09+0.01+0.98+0.02+0.0001) * (X + Y + Z + V) = 2.0001 * (X + Y + Z + V)
average memory access time = (2.0001 * (X + Y + Z + V)) / 4