ECEN 5623
Ayush Dhoot

Homework set 4
Due 2019/04/16
<u>These problems should be done individually, not with your project partner.</u>

1. Develop an example of a 32-bit Hamming encoded word (39 bits total) and show a correctable SBE scenario. Show the data word in a table like Figure 5.6 in the book.

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
		pW	*p01*	*p02*	*d01*	*p03*	*d02*	*d03*	*d04*	*p04*	*d05*	*d06*	*d07*	*d08*	*d09*	*d10*	*d11*	*p05*	*d12*	*d13*	*d14*	*d15*	*d16*	*d17*	*d18*	*d19*	*d20*	*d21*	*d22*	*d23*	*d24*	*d25*	*d26*	*p06*	*d27*	*d28*	*d29*	*d30*	*d31*	*d32*
Bit	D	x	x	x	0	x	0	1	1	x	0	1	1	1	0	0	0	x	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1	x	1	0	1	1	0	0
1	p01		0		0		0		1		0		1		0		0		1		1		1		0		1		0		1		1		1		1		0	
2	p02			0	0			1	1			1	1			0	0			0	1			0	0			1	0			0	1			0	1			0
4	p03					1	0	1	1					1	0	0	0					0	1	0	0					0	1	0	1					1	0	0
8	p04									0	0	1	1	1	0	0	0									1	1	1	0	0	1	0	1							
16	p05																	0	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1							
32	p06																																	1	1	0	1	1	0	0
	ED	0	0	0	0	1	0	1	1	0	0	1	1	1	0	0	0	0	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1	1	1	0	1	1	0	0

SYN		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
		pW	*p01*	*p02*	*d01*	*p03*	*d02*	*d03*	*d04*	*p04*	*d05*	*d06*	*d07*	*d08*	*d09*	*d10*	*d11*	*p05*	*d12*	*d13*	*d14*	*d15*	*d16*	*d17*	*d18*	*d19*	*d20*	*d21*	*d22*	*d23*	*d24*	*d25*	*d26*	*p06*	*d27*	*d28*	*d29*	*d30*	*d31*	*d32*
	ED	0	0	0	0	1	0	1	1	0	0	1	1	1	0	0	0	0	1	0	1	0	1	0	0	0	1	1	0	0	1	0	1	1	1	0	1	1	0	0
c01	0		0		0		0		1		0		1		0		0		1		1		1		0		1		0		1		1		1		1		0	
c02	0			0	0			1	1			1	1			0	0			0	1			0	0			1	0			0	1			0	1			0
c03	0					1	0	1	1					1	0	0	0					0	1	0	0					0	1	0	1					1	0	0
c04	1									1	0	1	1	1	0	0	0									0	1	1	0	0	1	0	1							
c05	1																	1	1	0	1	0	1	0	0	0	1	1	0	0	1	0	1							
c06	0																																	1	1	0	1	1	0	0
pW2	1	0	0	0	0	1	0	1	1	0	0	1	1	1	0	0	0	0	1	0	1	0	1	0	0	0	1	1	0	0	1	0	1	1	1	0	1	1	0	0
24	CD	0	0	0	0	1	0	1	1	0	0	1	1	1	0	0	0	0	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1	1	1	0	1	1	0	0

Check-Bits != 0 AND pW != pW2 => SBE, CAN CORRECT

2. For the foregoing problem, now show an uncorrectable MBE scenario.

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
		pW	*p01*	*p02*	*d01*	*p03*	*d02*	*d03*	*d04*	*p04*	*d05*	*d06*	*d07*	*d08*	*d09*	*d10*	*d11*	*p05*	*d12*	*d13*	*d14*	*d15*	*d16*	*d17*	*d18*	*d19*	*d20*	*d21*	*d22*	*d23*	*d24*	*d25*	*d26*	*p06*	*d27*	*d28*	*d29*	*d30*	*d31*	*d32*
Bit	D	x	x	x	0	x	0	1	1	x	0	1	1	1	0	0	0	x	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1	x	1	0	1	1	0	0
1	p01		0		0		0		1		0		1		0		0		1		1		1		0		1		0		1		1		1		1		0	
2	p02			0	0			1	1			1	1			0	0			0	1			0	0			1	0			0	1			0	1			0
4	p03					1	0	1	1					1	0	0	0					0	1	0	0					0	1	0	1					1	0	0
8	p04									0	0	1	1	1	0	0	0									1	1	1	0	0	1	0	1							
16	p05																	0	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1							
32	p06																																	1	1	0	1	1	0	0
	ED	0	0	0	0	1	0	1	1	0	0	1	1	1	0	0	0	0	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1	1	1	0	1	1	0	0

SYN		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
		pW	*p01*	*p02*	*d01*	*p03*	*d02*	*d03*	*d04*	*p04*	*d05*	*d06*	*d07*	*d08*	*d09*	*d10*	*d11*	*p05*	*d12*	*d13*	*d14*	*d15*	*d16*	*d17*	*d18*	*d19*	*d20*	*d21*	*d22*	*d23*	*d24*	*d25*	*d26*	*p06*	*d27*	*d28*	*d29*	*d30*	*d31*	*d32*
	ED	0	0	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1	1	1	0	1	1	0	0
c01	0		0		0		0		1		0		1		0		0		1		1		1		0		1		0		1		1		1		1		0	
c02	0			0	0			0	1			0	1			0	0			0	1			0	0			1	0			0	1			0	1			0
c03	1					0	0	0	1					1	0	0	0					0	1	0	0					0	1	0	1					1	0	0
c04	1									1	0	0	1	1	0	0	0									1	1	1	0	0	1	0	1							
c05	0																	0	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1							
c06	0																																	1	1	0	1	1	0	0
pW2	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0	1	1	1	0	0	1	0	1	1	1	0	1	1	0	0
MBE																																								

Check-Bits != 0 AND pW == pW2 => Double MBE detected, Can't CORRECT the data

3. **For the following Nand flash block update history for 2 sectors that contain 4 blocks each (e.g. 16K sectors, with 4K blocks), fill in the missing WRITE operations as needed and compute write-amplification.**

		#1 - Start	#2	#3	#4	#5	#6	#7
Sector Erased (S0, S1)		0,0	1,1	1,1	1,1	1,1	2,1	2,1
S1								
	PB7	FREE	FREE	FREE	LB3	LB3	LB3	LB3
	PB6	FREE	FREE	LB2	LB2	INVLD	INVLD	INVLD
	PB5	FREE	LB3	LB3	INVLD	INVLD	INVLD	INVLD
	PB4	FREE	LB2	INVLD	INVLD	INVLD	INVLD	INVLD
S0								
	PB3	FREE	FREE	FREE	LB1	LB1	FREE	LB1
	PB2	FREE	FREE	LB0	LB0	INVLD	FREE	FREE
	PB1	FREE	LB1	LB1	INVLD	INVLD	FREE	LB2
	PB0	FREE	LB0	INVLD	INVLD	INVLD	FREE	LB0
FS LBs Updated			0,1,2,3	0,2	1,3	0,2	0,2	0,2
FS LBs Cached						0,2	0,2	
Sector LBs Buffered							1	
		#8	#9	#10	#11	#12	#13	#14
Sectors Erased (S0, S1)	2,1	2,1	2,2	2,2	2,2	2,2	3,2	3,2
S1								
	LB3	INVLD	FREE	FREE	LB2	LB2	LB2	LB2
	INVLD	INVLD	FREE	FREE	LB0	LB0	LB0	LB0
	INVLD	INVLD	FREE	LB3	LB3	INVLD	INVLD	INVLD
	INVLD	INVLD	FREE	LB1	LB1	INVLD	INVLD	INVLD
S0								
	LB1	INVLD	INVLD	INVLD	INVLD	INVLD	FREE	FREE
	FREE	FREE	FREE	FREE	FREE	FREE	FREE	FREE
	LB2	LB2	LB2	LB2	INVLD	INVLD	FREE	LB3
	LB0	LB0	LB0	LB0	INVLD	INVLD	FREE	LB1
FS LBs Updated	0,2	1,3	1,3	1,3	0,2	1,3	1,3	1,3
FS LBs Cached		1,3	1,3			1,3	1,3	
Sector LBs Buffered								

```
#1 – All blocks FREE
#2 – Erase S0 & S1, WRITE LB 0, 1, 2, 3
#3 – Read LB 0, 2, Modify, WRITE LB 0, 2
#4 – Read LB 1, 3, Modify, WRITE LB 1, 3
#5 – Read LB 0, 2, Modify and Cache
#6 – Buffer LB 0, 1, 2, Erase S0
#7 – WRITE LB 0, 1, 2 to S0

Write Amplification = 11/10 = 1.1

#8 - Read LB 1, 3, Modify and Cache
#9 – Erase S1
#10 – WRITE – Back LB 1, 3 to S1
#11 – Read LB 0, 2, Modify, WRITE LB 0, 2
#12 – Read LB 1, 3, Modify and Cache
#13 – Erase S0
#14 – WRITE – Back LB 1, 3

Write Amplification = 17/16 = 1.0625
Total sector erases for both S0 and S1 = 2 + 3 = 5
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