Class CS 147, Sec 01
Homework 1
Due Date Feb 23, 2017 11:59 PM PST

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1. Table 1.1 Result Table

Code	Binary	Hex	Operation
muli r6, r3, 0x8FA7	0011 0100 0110 0110 1000 1111 1010 0111	0x34668FA7	r3 = r6 * 0x8FA7
add r3, r3, r1	0000 0000 0110 0001 0001 1000 0010 0000	0x611820	r3 = r3 + r1
nor r2, r3, r5	0000 0000 0110 0101 0001 0000 0010 0111	0x651027	r2 = ~(r3| r5)
jal 0x34F832	0000 1100 0011 0100 1111 1000 0011 0010	0xC34F832	RP = 0x34F832

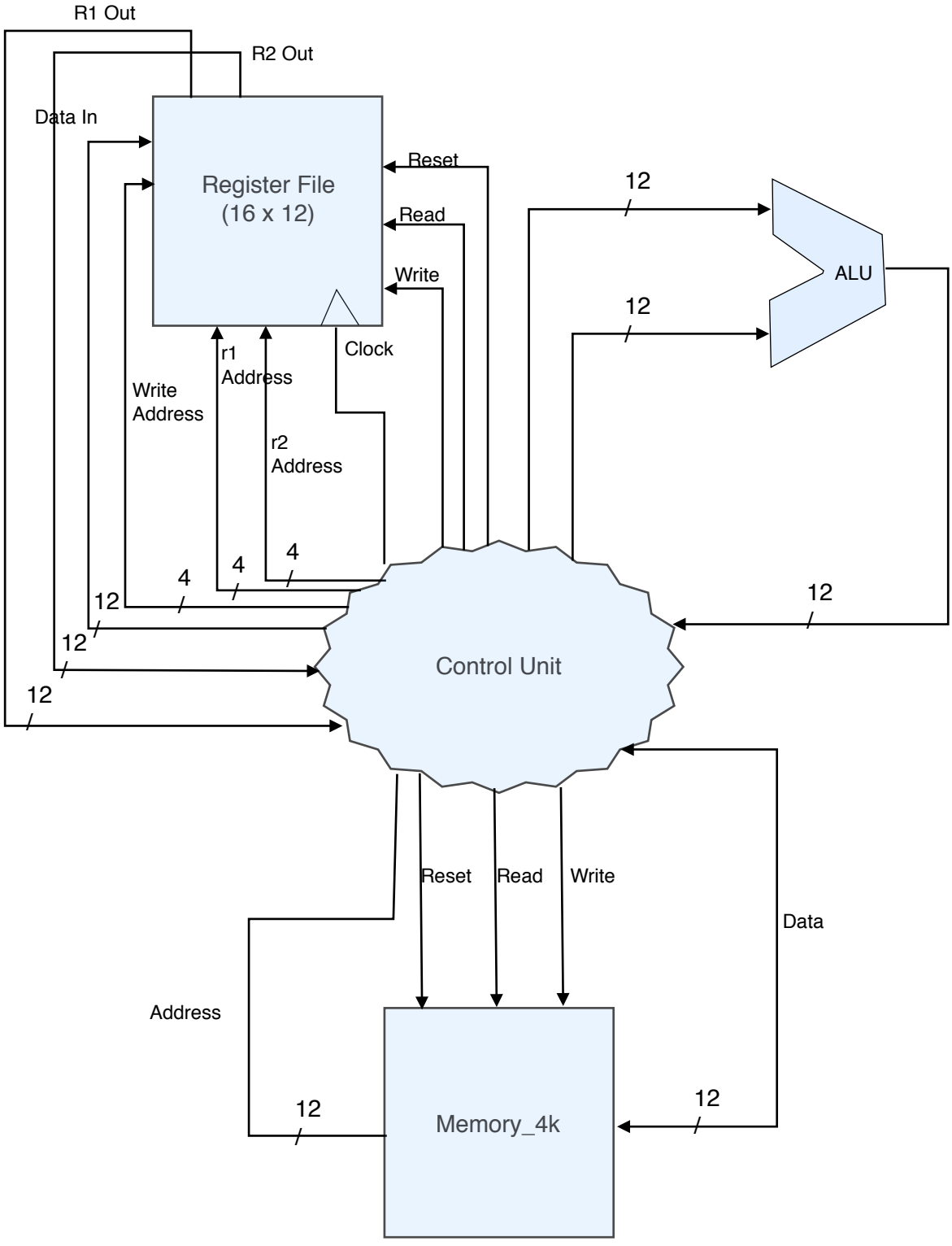
Table 1.2 Calculation Table

Code	Type	RS	RT	RD	SHAMT	FUNCT	IMM	ADDR
muli r6, r3, 0x8FA7	I	r3	r6				0x8FA7	
add r3, r3, r1	R	r3	r1	r3	0000	0x20		
nor r2, r3, r5	R	r3	r5	r2	0000	0x27		
jal 0x34F832	J							0x34F832

2. Table 2.1. Machine Code and execution result table

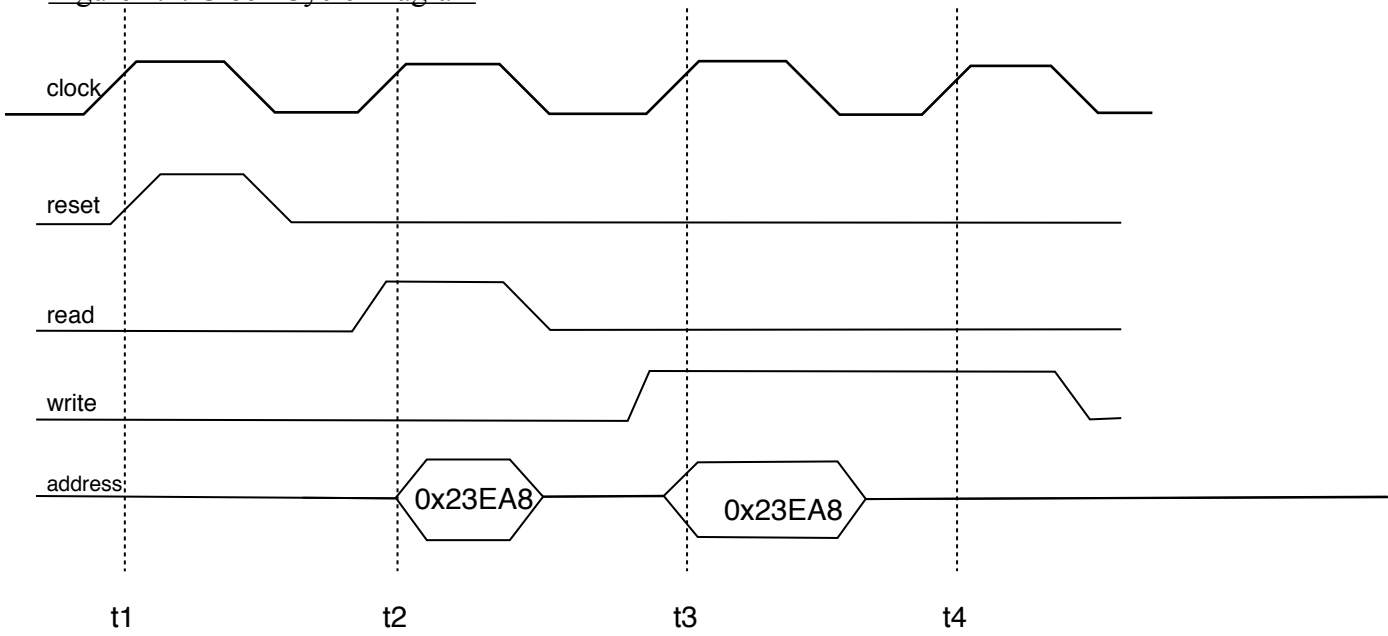
Code	Program Address	Content	Data Address	Content
addi r0, r0, 0x1008	0x0000 1000	0010 0000 0000 0000 0001 0000 0000 1000	0x01008000	21
sll r0, r0, 0xC	0x0000 1001	0000 0000 0000 0000 0000 0010 0100 0001	0x01008001	23
addi r2, r2, 0x9	0x0000 1002	0010 0000 0100 0010 0000 0000 0000 1001	0x01008002	25
LOOP:				
beq r1, r2, END	0x0000 1003	0001 0000 0100 0001 0001 0000 0000 1011	0x01008003	27
lw r3, r0, 0x0	0x0000 1004	1000 1100 0000 0011 0000 0000 0000 0000	0x01008004	29
lw r4, r0, 0x1	0x0000 1005	1000 1100 0000 0100 0000 0000 0000 0001	0x01008005	31
add r5, r3, r4	0x0000 1006	0000 0000 0110 0100 00101 0000 0010 0000	0x01008006	33
sw r5, r0, 0x0	0x0000 1007	1010 1100 0000 1001 0000 0000 0000 0000	0x01008007	35
addi r0, r0, 0x1	0x0000 1008	0010 0000 0000 0000 0000 0000 0000 0001	0x01008008	37
addi r1, r1, 0x1	0x0000 1009	0010 0000 1000 0100 0000 0000 0000 0001	0x01008009	19
jmp LOOP	0x0000 100A	0000 1000 0000 0000 0001 0000 0000 0011	0x0100800A	
END:				
sw r5, r0, 0x0	0x0000 100B	1010 1100 0000 1001 0000 0000 0000 0000	0x0100800B	

3. Figure 3.1: Complete processor schematic



4. Clock Diagram
   (a) Time period of the clock is 400ps. 1/(2.5GHz) * 1000 = ps
   (b) The clock is at a logic low for 230ps. 400* .4 = 160 | 400 - 160 - 10 = logic low

Figure 4.1: Clock Cycle Diagram



5. Table 5.1: Solutions

Binary	Hex	Octal	Unsigned Decimal	Signed Deciamal
1101 0011	D3	323	211	-45
1000 1011	8B	213	139	-117
1010 1111	AF	257	175	-81
1010 1101	AD	255	173	-83

Table 5.2: Work for Solutions in

To Hexadecimal	To Binary / Signed Decimal	To Unsigned Decimal	To Octal
211 % 16 = 13 R 316 13 % 16 = 0 R 13 or D16	139 % 2 = 69 R 1 69 % 2 = 34 R 1 34 % 2 = 17 R 0 17 % 2 = 8 R 1 8 % 2 = 4 R 0 4 % 2 = 2 R 0 2 % 2 = 1 R 0 1 % 2 = 0 R 1	1101 00112 = 2^7 *1 + 2^6 *1 + 2^5 * 0 + 2^4 * 1 + 2^3 * 0 + 2^2 * 0 + 2^1 * 1 + 2^0 * 1 = 211	175 % 8 = 21 R7 21 % 8 = 2 R5 2 % 8 = 0 R 2
139 % 16 = 8 R 11 or B16 8 % 16 = 0 R 816	175 % 2 = 87 R 1 87 % 2 = 43 R 1 43 % 2 = 21 R 1 21 % 2 = 10 R 1 10 % 2 = 5 R 0 5 % 2 = 2 R 1 2 % 2 = 1 R 0 1 % 2 = 0 R 1	2138 = 8^2 * 2 + 8^1 *1 + 8^0 * 3 = 139	211 % 8 = 26 R3 26 % 8 = 3 R2 3 % 8 = 0 R 3
Since the unsigned decimal 173 and 175 are two apart using the provided AF from the table and subtracting 216 = AD16	-83 % 2 = -41 R 1 -41 % 2 = 20 R 1 -20 % 2 = 10 R 0 -10 % 2 = 5 R 0 -5 % 2 = 2 R 1 -2 % 2 = 1 R 0 -1 % 2 = 0 R 1 0101 0011 -> 1010 1100 + 1 = 1010 11012	AF16 = 16^1 * 10 + 16^0 * 15 = 175	173 % 8 = 21 R5 21 % 8 = 2 R5 2 % 8 = 0 R 2
		-83 = 1010 1101_2 = 2^7 *1 + 2^6 *0 + 2^5 * 1 + 2^4 * 0 + 2^3 * 1 + 2^2 * 1 + 2^1 * 0 + 2^0 * 1 = 173	

6. Using 2's Compliment for binary arithmetic

(a) $6_{10}/2 = 3$ R=0 $-4_{10}/2 = -2$ R=0

$3_{10}/2 = 1$ R=1 $-2_{10}/2 = -1$ R=0

$1_{10}/2 = 0$ R=1 $-1_{10}/2 = 0$ R=1

$0_{10}/2 = 0$ R=0 $0_{10}/2 = 0$ R=0 *Since negative switch 0s and 1s and add 1

$6_{10} = 0110_2$ $-4_{10} = 0100$ –> 1011 –> 1011 + 1 = 1100_2

(b) i) Zero Extension: $6_{10} = 0110$ –> 0000 0110_2 $-4_{10} = 1100_2$ –> 0000 1100_2

ii) Sign Extension: $6_{10} = 0110$ –> 0000 0110_2 $-4_{10} = 1100_2$ –> 1111 11 00_2

7. Truth Tables for Boolean Functions

(a) F(x,y,z)=x'y+z

x	y	z	x'y	x'y + z
0	0	0	0	0
0	0	1	0	1
0	1	0	1	1
0	1	1	1	1
1	0	0	0	0
1	0	1	0	1
1	1	0	0	0
1	1	1	0	1

(b) F(x, y, z) = (xyz') + (x'y'z)

x	y	z	xyz'	x'y'z	(xyz') + (x'y'z)
0	0	0	0	0	0
0	0	1	0	1	1
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	1	0	1
1	1	1	0	0	0

8. Boolean Algebra Manipulation

(a) **a+b + (ab)' = 1**

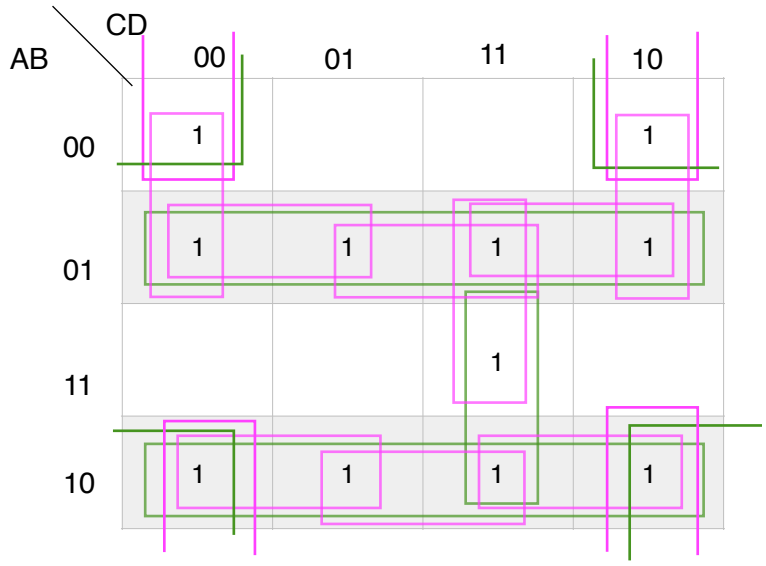
a + b + a' + b' by identity 17 (DeMorgan's)
a + a' + b + b' by identity 10 (Commutative)
1 + 1 by identity 7
= 1 by identity 3

(b) **w'.(wxyz)' = w'**

w'(w'+x'+y'+z') by Identity 17 (DeMorgan's)
w'w' + w'x' + w'y' + w'z' by Identity 14 (Distributive)
w' + w'x' + w'y' + w'z' by Identity 7
w'(1 + (x'y' z') by Identity 14 (Distributive)
w'(1) by Identity 3
= w' by Identity 2

9. K-Mapping Technique

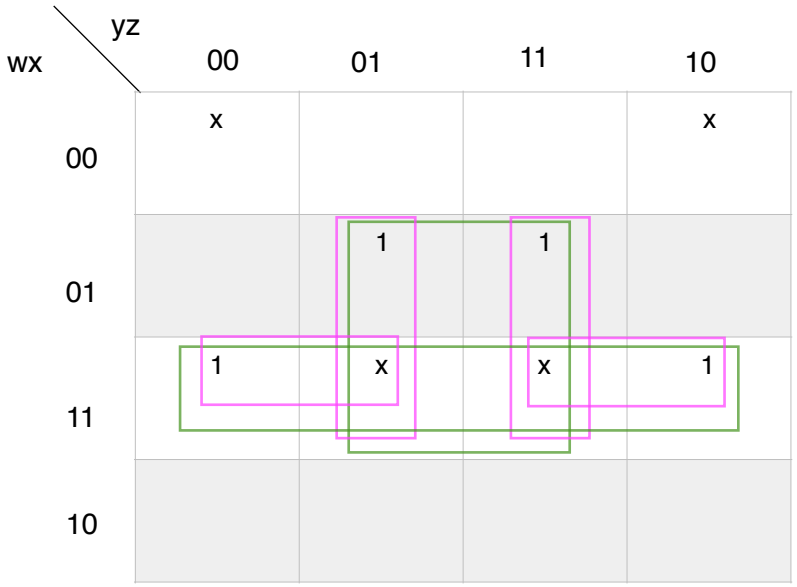
(a) f(A,B,C,D)= ΠM(1,3,12,13) =∑m(0, 2, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15)
= B'D' + A'B + AB' + ACD



Essential Prime Implicants

Non-Essential Prime Implicants

(b) f (w, x, y, z) = ∑m(5, 7, 12, 14) + d(0, 2, 13, 15) = xz + wx

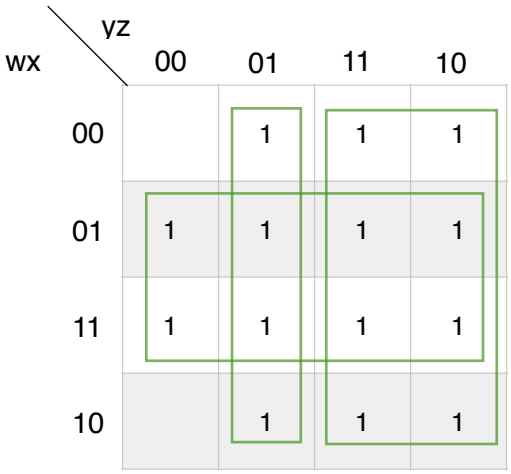


Essential Prime Implicants

Non-Essential Prime Implicants

10. Digital Circuit

Unsigned Decimal	Signed Decimal	W	X	Y	Z	Output M
0	0	0	0	0	0	0
1	1	0	0	0	1	1
2	2	0	0	1	0	1
3	3	0	0	1	1	1
4	4	0	1	0	0	1
5	5	0	1	0	1	1
6	6	0	1	1	0	1
7	7	0	1	1	1	1
8		1	0	0	0	0
9	-7	1	0	0	1	1
10	-6	1	0	1	0	1
11	-5	1	0	1	1	1
12	-4	1	1	0	0	1
13	-3	1	1	0	1	1
14	-2	1	1	1	0	1
15	-1	1	1	1	1	1



F(W,X,Y,Z) = ∑m (1,2,3,4,5,6,7,9,10,11,12,13,14,15)
–> X + Y + Y'Z
M = X + Y + Y'Z