CS147 HW1
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1.
a. the size of shamt is determined by the size of the memory over the number of registers.
Since shamt is 6 bits, shamt = $\log_2(x)$ = 6 bits, x = 64
So, 2KB / number of registers = 64bits, 16384 / 64 = 256
Number of registers = **256**

b. For R-type, rs + rd + rt = 64bits – (opcode + shamt + fucnt) = 64 – (10 + 6 + 24) = 24
So, It has 24 / 3 = 8 bit for each, rs, rt, rd.
For I-type, there are opcode, rs, rt, and immediate.
So I-type has 38 bits for immediate.
Since 2's complement form is used, the range is **[$-2^{37,}$ 2^{37}-1]**

c. To get the maximum number of instructions, it needs to add up all three R-type, I-type, J-type instructions.
opcode is 0X0 for R-type and fucnt has 24 bit on the graph, so it has 2^{24} = 16,777,216 instructions.
For J and I type has 10bit for opcode 2^{10} - 1 =1023 instructions
So, **16,778,239** instructions in total.

d. Since memory has 32GB, (1GB = 2^{30} byte)
32 GB = 32 * 2^{30} byte = 34359738368 byte * (8 bit/1byte) = 274877906944 bit
274877906944 /32 = 8589934592 address buckets.
$\log_2(8589934592)$ = 33
It has **33** address ports.

e. Since the memory is running with 1.2 GHz clock, the processor's clock period T = 1/frequency= 1 / 1.2GHz = 0.833*10-9 sec= 0.833 ns.

f. Since Write transaction is 25% with 10 % of write operation right after read operation,
4 million * 0.75 = 3 million of read transaction
4 million * 0.25 * 0.9 = 0.9 million of write transaction
4 million * 0.25 * 0.1 = 0.1 million of write/read transaction
Since this memory need one cycle to complete read and write request and need another one more cycle for read/write request,
3 million * 1 cycle = 3 million cycle
0.9 million * 1 cycle = 0.9 million cycle
0.1 million * 2 cycle = 0.2 million cycle
Total clock cycle is 4.1 million cycle

4.2 million clock cycle * (0.833 ns / 1 clock cycle) * (1*10^{-6} ms / 1 ns) = 3.4153ms
But, since 4 million 64 bit data transaction
3.4153ms * 2 = **6.8306ms**

2.

a. TiLaSoDoReMiFa = $(6540123)_7$

$= (6*7^6 + 5*7^5 + 4*7^4 + 0*7^3 + 1*7^2 + 2*7^1 + 3*7^0) = (799599)_{10}$

Divide by	Quotient	Remainder
7	1546781	
7	220968	5(La)
7	31566	6(Ti)
7	4509	3(Fa)
7	644	1(Re)
7	92	0(Do)
7	13	1(Re)
7	1	5(La)
	0	1(Re)

b. $(1546781)_{10}$ = LaTiFaReDoReLaRe

3.

a. $F(x, y, z) = x'z + xy = x'z(y + y') + xy$

$= x'y'z + x'yz + xy$

$= x'y'z + y(x'z + x)$

$= x'y'z + y((x+x')(x+z))$

$= x'y'z + y(x+z)$

$= x'y'z + yz + xy$

b. $F(a, b, c, d) = a'b'c'd' + a'b'cd + a'b'cd' + ab'c'd' + ab'cd' + ab'cd$

$= b'(a'c'd'+a'cd+a'cd'+ac'd'+acd'+acd)$

$= b'(c'd'(a'+a) + c(a'd + a'd' + ad' + ad))$

$= b'(c'd' + c)$

$= b'((c'+c)(d'+c))$

$= b'(c+d')$

c.

X	**Y**	**Z**	**x'z + xy**	**x'y'z + yz + xy**
0	0	0	0	0
0	0	1	1	1
0	1	0	0	0
0	1	1	1	1
1	0	0	0	0
1	0	1	0	0
1	1	0	1	1
1	1	1	1	1

d.

a	b	c	d	a’b’c’d’ + a’b’cd + a’b’cd’ + ab’c’d’ + ab’cd’ + ab’cd	b’(c+d’)
0	0	0	0	1	1
0	0	0	1	0	0
0	0	1	0	1	1
0	0	1	1	1	1
0	1	0	0	0	0
0	1	0	1	0	0
0	1	1	0	0	0
0	1	1	1	0	0
1	0	0	0	1	1
1	0	0	1	1	0
1	0	1	0	1	1
1	0	1	1	1	1
1	1	0	0	0	0
1	1	0	1	0	0
1	1	1	0	0	0
1	1	1	1	0	0

4.

a. f(A,B,C,D)=∑m(0,5,7,8,10,12,14,15)

- Prime implicants = ad’ + a’bd + bc’d’ + bcd + abc
- Essential prime implicants = ad’ + a’bd + bc’d’ + bcd

OR

ad’ + a’bd + bc’d’ + abc

b. f(w, x, y, z) = ∑ m (1,3,4,7,11) + d(5, 12, 13, 14, 15)

- Prime implicants = yz + w`z + xy`
- Essential prime implicants = yz + w`z + xy`

5.

W	X	Y	Z	Decimal	output
0	0	0	0	0	**1**
0	0	0	1	1	**1**
0	0	1	0	2	**1**
0	0	1	1	3	**1**
0	1	0	0	4	0
0	1	0	1	5	0
0	1	1	0	6	**1**
0	1	1	1	7	0
1	0	0	0	8	0
1	0	0	1	9	**1**
1	0	1	0	10	0
1	0	1	1	11	0
1	1	0	0	12	**1**
1	1	0	1	13	**1**
1	1	1	0	14	**1**
1	1	1	1	15	**1**

So, $f(w, x, y, z) = \sum m(0, 1, 2, 3, 6, 9, 12, 13, 14, 15) = w'x' + w'yz' + wx + wy'z$