CS 3843 Computer Organization, Fall 2013 Assignment 6

Date Assigned: Monday, November 25, 2013

Date Due: Monday, December 2, 2013

(100 points) This assignment is due at the beginning of class. **You must show how you got your answers to receive credit.**

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1. (30 points) For each byte sequence listed, determine the Y86 instruction sequences it encodes. If there is some invalid byte in the sequence, show the instruction sequence up to that point and indicate where the invalid value occurs. For each sequence, we show that the starting address, then a colon, and then the byte sequence.

   1) 0x300: 50540700000010f0b01f

   Sol:
   ```
   0x300:  505407000000  |  mrmovl  7(%esp), %ebp
   0x306:  10            |  nop
   0x307:  f0            |  .byte  0xf0  #invalid instruction code
   0x308:  b01f          |  popl  %ecx
   ```

   2) 0x400: 6113730004000000

   Sol:
   ```
   0x400:                |loop:
   0x400:  6113          |  subl  %ecx, %ebx
   0x402:  7300040000    |  je  loop
   0x407:  00            |  halt
   ```

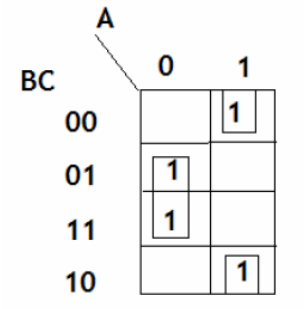
   3) 0x500: 6362a0f0

   Sol:
   ```
   0x500:  6362          |  xorl  %esi, %edx
   0x502:  a0            |  .byte  0xa0   # push instruction code
   0x503:  f0            |  .byte  0xf0   #  Invalid register specifier byte
   ```

2. (14 points) Find the minimum sum-of-products expression for each of these functions.

   1) $f(A,B,C) = m_1 + m_3 + m_4 + m_6$ (7 points)

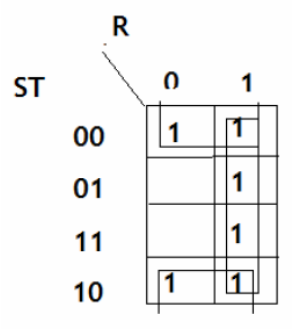
   Sol:



   $F = A'C + AC'$

2) $f(r,s,t) = r't' + rs' + rs$ (7 points)

Sol:

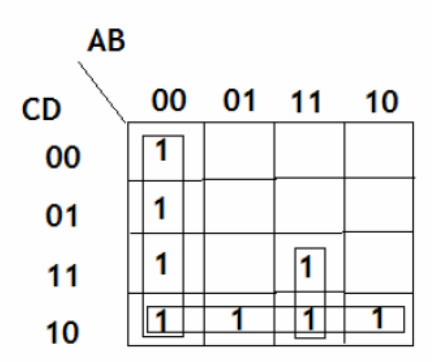


$F = T' + R$

2. 1) (10 points) Plot the following function on a Karnaugh map. (Do not expand to minterm form before plotting.

$$F(A,B,C,D) = A'B' + CD' + ABC + A'B'CD' + ABCD'$$

Sol:

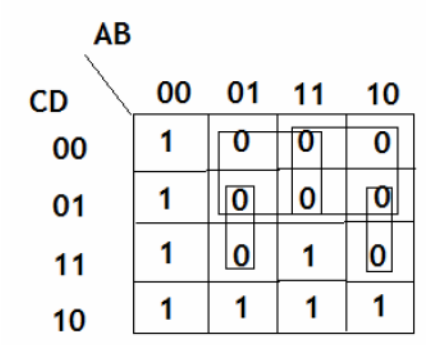


2) (7 points) Find the minimum sum-of-product

Sol: $F = A'B' + CD' + ABC$

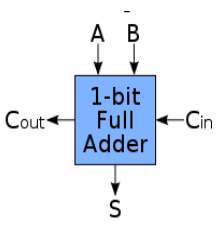
3) (7 points) Find the minimum product-of-sum.

Sol:



$F = (A + B' + D')(B' + C)(A' + C)(A' + B + D')$

3. (26 points) Draw the truth table for 1-bit full adder and derive the Boolean expression for C_{out}, S in terms of A, B, C_{in}. There are 3 inputs and 2 outputs. The truth table should have 8 lines. Arrange the columns in the following order: A, B, C_{in}, C_{out}, S.



1) (8 points) Fill the truth table for columns C_{out} and S.

2) (8 points) Draw the Karnaugh-Map.

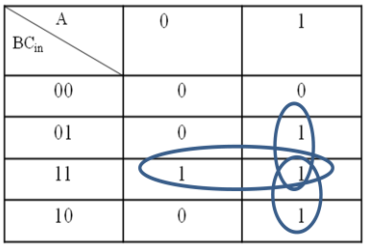
3) (5 points) Derive the minimum sum-of-product solution for S and C_{out}.

4) (Extra-credit 5 points) Derive the minimum product-of-sum solution for S and C_{out}.

Sol: 1) Truth-Table

A	B	C_{in}	C_{out}	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

2) Karnaugh-Map for C_{out}



$$C_{out} = BC_{in} + AC_{in} + AB$$

Karnaugh Map for S

BC_{in} \ A	0	1
00	0	1
01	1	0
11	0	1
10	1	0

$$S = A'B'C_{in} + A'BC'_{in} + AB'C'_{in} + ABC_{in}$$
$$= A'(B'C_{in} + BC'_{in}) + A(B'C'_{in} + BC_{in}) = A'(B \oplus C_{in}) + A(B \oplus C_{in})' = A \oplus B \oplus C_{in}$$

4) To obtain minimum product-of-sum solution, we group zeros in the Karnaugh map for C_{out} and S.

Sol: Karnaugh Map for C_{out}

A / BC_{in}	0	1
00	0	0
01	0	1
11	1	1
10	0	1

$$C_{out} = (A + B)(B + C_{in})(A + C_{in})$$

Same Karnaugh for S, but we focus on zero items (Maxterm)

$$S = (A + B + C_{in})(A' + B + C'_{in})(A + B' + C'_{in})(A' + B' + C_{in})$$

4. (6 points) Draw a block diagram for a 7-word mux. How many control inputs are needed?

Sol: 3 control inputs are needed.