COL215_2018 Minor 1

SAKSHAM DHULL

TOTAL POINTS

7 / 10

QUESTION 1

1 Question 1 2 / 2

✓ **+ 2 pts Correct proof**

+ **0 pts** Incorrect proof
- **1 pts** Using derived equalities
- **1 pts** Missing steps

+ **0 pts** Unattempted

QUESTION 2

2 Question 2 0 / 3

+ **2 pts** Correct
+ **1 pts** Partially correct
+ **0.5 pts** Click here to replace this description.

✓ **+ 0 pts Incorrect**

Placement of literals in K map is wrong. SO entire solution is wrong

QUESTION 3

3 Question 3 2 / 2

✓ **+ 2 pts 8 or more values of f are correct out of 10**

+ **1.5 pts** 6 or 7 values of f are correct out of 10
+ **1 pts** 4 or 5 values of f are correct out of 10
+ **0.5 pts** 2 or 3 values of f are correct out of 10
+ **0 pts** Less than 2 values of f are correct out of 10

QUESTION 4

4 Question 4 3 / 3

+ **0 pts** 3 or less are correct
+ **1 pts** 4 to 7 are correct
+ **2 pts** 8 to 11 are correct

✓ **+ 3 pts 12 and more are correct**

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1. Using basic properties of Boolean Algebra operators '+' and '.' and the definitions of inverse and identity elements, prove the following equality. Do not use any derived properties.

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

LHS

[2]

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

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

$= 0 + \bar{x}.y + 0 + \bar{x}.y.z$
$+ xyz + yz + xz$

$= \bar{x}.y(1+z) + (x+1)yz + xz$

$= \bar{x}.y + yz + xz$

$= 0 + \bar{x}.y + (x+y)z$

$= x.\bar{x} + \bar{x}.y + (x+y)z$

$= (x+y).(\bar{x}+z)$

$x_3 x_4$

$x_1 x_2$

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

P

$\bar{x}_1 \bar{x}_2 x_3 \bar{x}_4 + \bar{x}_1 \bar{x}_3 x_4$

+

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

Q

$0 0 \times 0$

$\bar{x}_1 x_2 (x_3$

$(x_3 \bar{x}_4 + \bar{x}_3 x_4) \cdot x_1 \bar{x}_2$

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

(11)

+

$\bar{x}_1 \bar{x}_3 \bar{x}_4$

10×1

$x_1 \bar{x}_2 x_4 + \bar{x}_1 \bar{x}_4 + \bar{x}_2 x_1 x_3$

$+ \bar{x}_1 x_2 x_3$ $101x$

$011x$

$(x_3 + \bar{x}_4) \cdot \bar{x}_1 x_2$

$\bar{x}_1 x_2 x_3 (x_3 + \bar{x}_4)$

$x_1 x_2 (x_3 + x_4)$

$\bar{x}_4 x_2 \bar{x}_4$

$\bar{x}_1 \bar{x}_2 (x_3 + x_4)$

$\bar{x}_1 x_2 x_3 + \bar{x}_1 \bar{x}_4$

$0.\bar{b} + 0.b$

$\bar{x}_1 x_2 x_3 x_4$

	00	01	10	11
00	1	0	1	0
01	1	0	1	1
10	0	1	–	0
11	0	0	0	

$x_3 + x_4$

$ab + \bar{a}b$

	00	01	10	11
00				
01				
10				
11				

$\bar{x}_1 \bar{x}_3 \bar{x}_4 + x_3 \bar{x}_4 (x_1 + x_2)$

$+ \bar{x}_3 x_4 \cdot x_1$

$+ x_1 x_2 x_3 x_4$

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2. Find the minimum cost SoP implementations for the following two functions considered separately (only expressions are required, not circuits). If you were allowed to share product terms among the two, what combined minimum cost implementation is possible. Note that in combined minimum implementation, the individual implementations need not be minimum. Here the cost is measured as "literal count", that is, total number of literals present in the expression, where each appearance of a variable in true or complemented form is counted as a literal. For example, the expression $x_1 . x_2' + x_1 . x_3$ has a literal count of 4.

$f(x_1, x_2, x_3, x_4) = \sum m\ (0, 2, 4, 6, 7, 9) + D\ (10, 11)$
$g\ (x_1, x_2, x_3, x_4) = \sum m\ (2, 4, 9, 10, 15) + D\ (0, 13, 14)$

[3]

f.

x_1	x_2	x_3	x_4	f	g
0	0	0	0	1	-
0	0	0	1	0	0
0	0	1	0	1	1
0	0	1	1	0	0
0	1	0	0	1	1
0	1	0	1	0	0
0	1	1	0	1	0
0	1	1	1	1	0
1	0	0	0	0	0
1	0	0	1	1	1
1	0	1	0	-	1
1	0	1	1	-	0
1	1	0	0	0	0
1	1	0	1	0	-
1	1	1	0	0	-
1	1	1	1	0	1

Karnaugh Maps

f

x_1x_2 \ x_3x_4	00	01	10	11
00	1	0	1	0
01	1	0	1	1
10	0	1	-	-
11	0	0	0	0

g

	00	01	10	11
00	-	0	1	0
01	1	0	0	0
10	0	1	1	0
11	0	-	-	1

min cost SOP(f) = $x_1 . \bar{x}_2 . x_4 + \bar{x}_1 . \bar{x}_4 + \bar{x}_1 . x_2 . x_3 + \bar{x}_2 . x_1 . x_3$

min Cost SOP(g) = $\bar{x}_1 \bar{x}_3 \bar{x}_4 + \bar{x}_1 . x_3 . \bar{x}_4 + x_1 . \bar{x}_3 . x_4 + \bar{x}_2 . x_3 . \bar{x}_4 + x_1 x_2 x_3 x_4$

with sharing.

min cost (f) = $\bar{x}_1\bar{x}_2\bar{x}_4 + x_1\bar{x}_2x_3\bar{x}_4 + x_1\bar{x}_2\bar{x}_3x_4 + \bar{x}_1x_2x_3 + \bar{x}_1\bar{x}_3\bar{x}_4$

minCost (g) = $\bar{x}_1\bar{x}_2\bar{x}_4 + x_1\bar{x}_2x_3\bar{x}_4 + x_1\bar{x}_2\bar{x}_3x_4 + x_1x_2x_3x_4 + \bar{x}_1\bar{x}_3\bar{x}_4$

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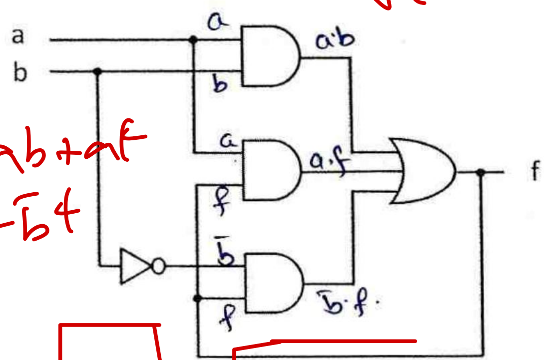
3. Consider the circuit shown below. Waveforms for its inputs are given. Draw the waveform for its output. Assume f to be '0' initially.

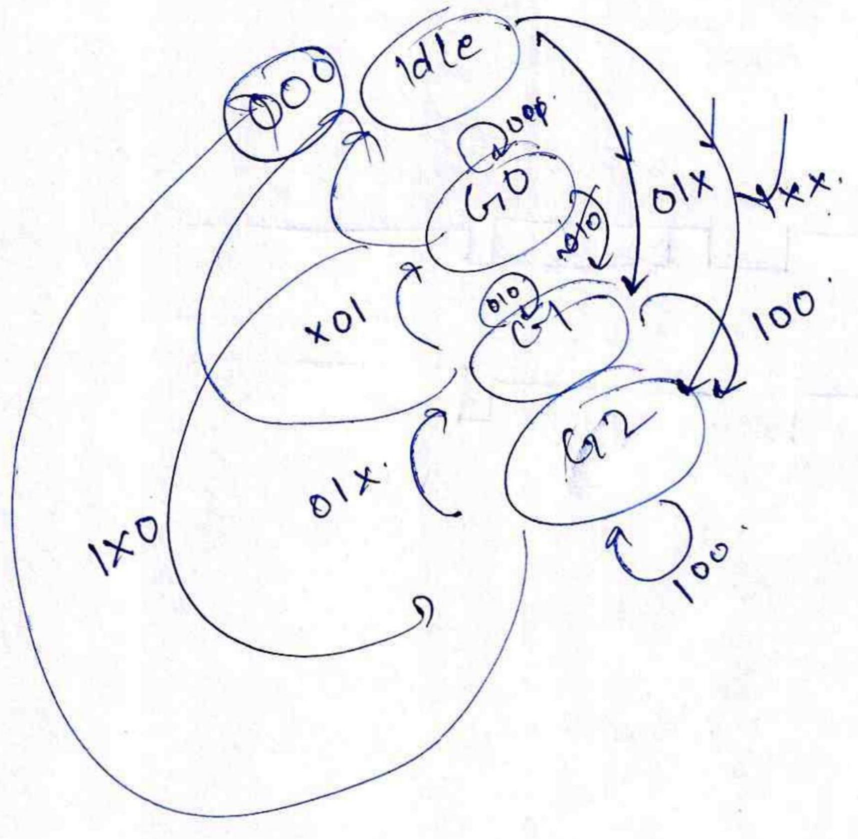
$f(t+1) = ab + af + \bar{b}f$

$f(t+1) = ab + af + \bar{b}f$



1, 0, 1

[2]



000
Idle
000
G0
010
010
01X
XXX
X01
G1
100
G2
01X
1X0
100

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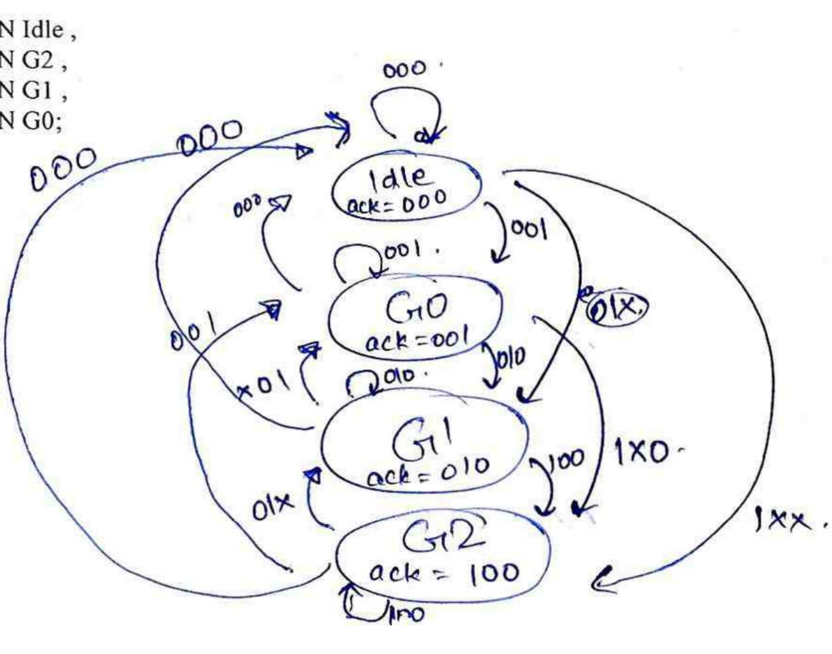
4. A modified version of the arbiter discussed in class is given below in terms of its Entity and architecture description in VHDL. Draw its state transition diagram. Do not show multiple transitions between any pair of present state and next state.

```
ENTITY arbiter IS
  PORT (clk : IN bit;
        req : IN bit_vector (2 DOWNTO 0);
        ack : OUT bit_vector (2 DOWNTO 0)
       );
END arbiter;
ARCHITECTURE FSM OF arbiter IS
  TYPE state_type IS (Idle, G0, G1, G2);
  SIGNAL state : state_type;
BEGIN
  PROCESS (clk)
  BEGIN
    IF clk'EVENT AND clk = '1' THEN
      IF req = "000" THEN state <= Idle;
      ELSIF req = "100" THEN state <= G2;
      ELSIF req = "010" THEN state <= G1;
      ELSIF req = "001" THEN state <= G0;
      ELSE
        CASE state IS
        WHEN Idle =>
          IF     req (2) = '1' THEN state <= G2;
          ELSIF req (1) = '1' THEN state <= G1;
          END IF;
        WHEN G2 =>
          IF req (2 DOWNTO 1) = "01" THEN state <= G1;
          END IF;
        WHEN G1 =>
          IF req (1 DOWNTO 0) = "01" THEN state <= G0;
          END IF;
        WHEN G0 =>
          IF req (2) = '1' AND req (0) = '0' THEN state <= G2;
          END IF;
        END CASE;
      END IF;
    END IF;
  END PROCESS;
  WITH state SELECT
    ack <= "000"  WHEN Idle ,
           "100"  WHEN G2 ,
           "010"  WHEN G1 ,
           "001"  WHEN G0;
END FSM;
```



[3]

$0 + \bar{x}y + xz + yz$.