Name:_____ Student Number:_____

CMPT 150 : TEST #2 SOLUTION

Time: 50 minutes 30 MARKS
3 Questions 2 Pages (both sides)
A

INSTRUCTIONS

1. **ALL questions to be answered on the test paper.** The backs of pages can be used for rough work.
2. Place your name at the top of each page. No part of the test paper is to be removed from the lecture room.
3. CAUTION: In accordance with the Academic Honesty Policy (T10.02), academic dishonesty in any form will not be tolerated. Prohibited acts include, but are not limited to, the following:
   - making use of any books, papers, electronic devices or memoranda, other than those authorized by the examiners.
   - speaking or communicating with other students who are writing examinations.
   - copying the work of other candidates or purposely exposing written papers to the view of other candidates.

1. A combinational device has the following function table:

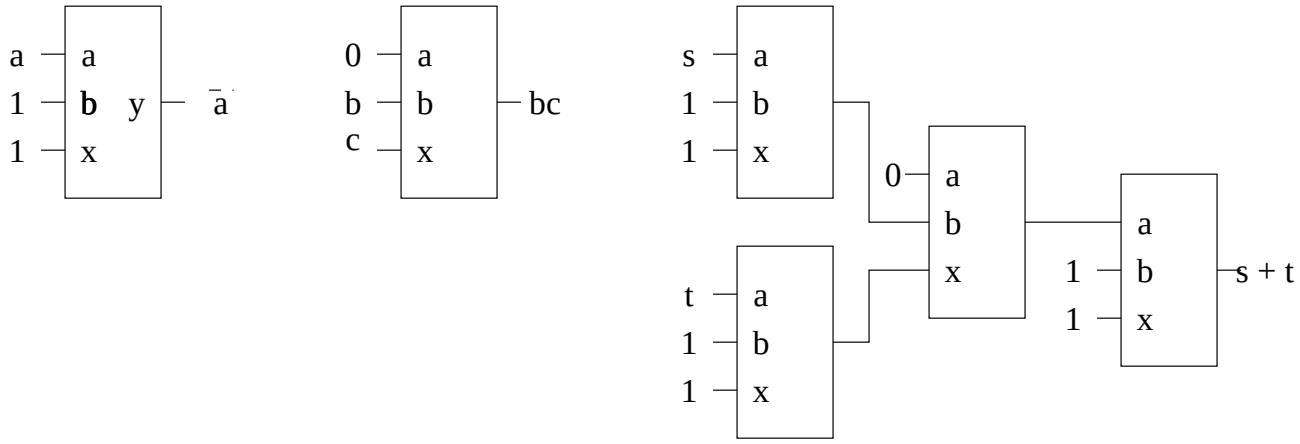
```
a b x | y
------|--
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 1
1 0 0 | 0
1 0 1 | 1
1 1 0 | 0
1 1 1 | 0
```

a. Show how to implement this device using a 4x1 MUX and one inverter. **(4 marks)**

```
From the function table: y(a,b,x) = a'bx + ab'x
mux4(s1,s0,d0,d1,d2,d3)
         = dos1's0' + d1's1's0 + d2s1s0' + d3s1s0

mux4(a,b,0,x,x,0) = 0a'b' + xa'b +xab' + 0ab
                  = a'bx + ab'x
```

b. (Question 1 continued) Demonstrate that this device is functionally complete. **(6 marks)**

```
y(a,b,x) = a'bx + ab'x
To implement NOT: y(a,1,1) = a'11 + a1'1 = a'

To implement AND: y(0,b,c) = 0'bc + 0b'c
                           = bc
(Also y(a,0,c) = ac)

To implement OR: (s + t) = (s't')'
                         = y((s't'),1,1)
                         = y(y(0,s',t'),1,1)
                         = y(y(0,y(s,1,1),y(t,1,1)),1,1)
  (In otherwords, use two devices to complement s and t,
  then "and" their outputs, and complement the result.)
```



2. The following characteristic table describes a simple sequential circuit:

Q	x	Q+
0	0	0
0	1	1
1	0	1
1	1	0

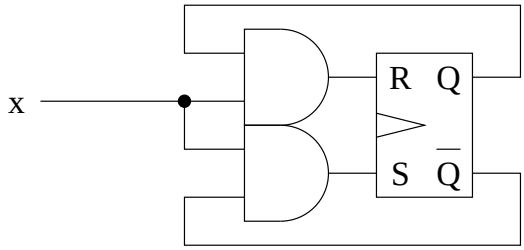
a. Construct the excitation table for this circuit. **(2 marks)**

Q	Q+	x
0	0	0
0	1	1
1	0	1
1	1	0

b. Construct a logic diagram for the circuit that uses an RS flip-flop. **(4 marks)**

Q	x	Q+	R	S
0	0	0	X	0
0	1	1	0	1
1	0	1	0	X
1	1	0	1	0

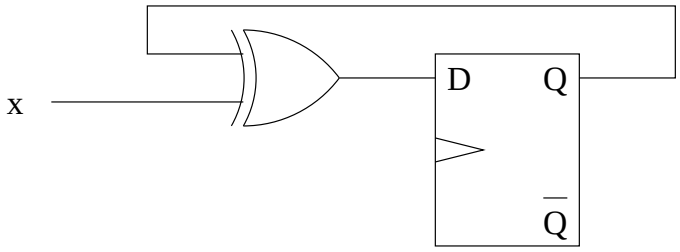
$R = Qx,\ S = Q'x$



c. Construct a logic diagram for the circuit that uses a D flip-flop. **(4 marks)**

Q	x	Q+	D
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	0

$D = Q'x + Qx' = Q \oplus x$



3. Using RS flip-flops, Construct a sequential circuit that generates the sequence 0, 1, 3, 2, and repeats. A new value is displayed on the rising edge of each clock enable input.

Q1	Q0	Q1+	Q0+	R1	S1	R0	S0
0	0	0	1	X	0	0	1
0	1	1	1	0	1	0	X
1	0	0	0	1	0	X	0
1	1	1	0	0	X	1	0

R1 = Q0′ R0 = Q1
S1 = Q0   S0 = Q1′