DALHOUSIE UNIVERSITY

Department of Electrical & Computer Engineering

ECED 2200 - Digital Circuits

Final Examination **Winter 2013**

Name: ____________________ **Student ID:** ____________

Marks: Total marks out of 50

Question	Marks
1	10
2	10
3	10
4	10
5	10
Total	50

1.- Two Boolean functions are given below, f_1 is given using the shorthand minterm form and f_2 is given using the shorthand maxterm form.

(i) $f_1(A,B,C,D) = \sum m_i(0,1,2,3,8,10,12,14)$

(ii) $f_2(A,B,C,D) = \prod M_i(6,7,8,12,13,15)$

(a) Use K-maps to find the simplest sum-of-products (SoP) expression for f_1 and the simplest product-of-sums (PoS) expression for f_2. [6 pts]

(b) Find hazard-free implementations for f_1 in SoP and f_2 in PoS. [4 pts]

2.- (a) Draw the circuit for a 4-bit shift register using D flip-flops that can perform parallel-to-serial conversion as well as serial-to-parallel conversion. [6 pts]

(b) In your diagram, identify:

i) The serial input terminal,

ii) The serial output terminal,

iii) The parallel input terminals, and

iv) The parallel output terminals. [4 pts]

3.- (a) Provide the state transition table for an asynchronous binary up-counter that goes through the sequence 0000, 0001, 0010, ..., 1110, 1111, 0000, 0001, ... [2 pts]

(b) Draw the ripple binary up-counter in (a) using T flip-flops. [3 pts]

(c) Provide the state transition table for a decade up-counter. [2 pts]

(d) Build the asynchronous decade binary up-counter in (c) using T flip-flops. [3 pts]

Hint: Modify the counter in (b) such that it turns into a decade counter.

4.- Use JK flip-flops to design a finite state machine (FSM) that works as a 2-bit binary synchronous up-counter when its input X = 0 and as a 2-bit binary synchronous down-counter when its input X = 1.

(a) Draw the state transition diagram. [2 pts]

(b) Build the state transition table. Include values of flip-flop inputs. [3 pts]

(c) Find minimized logic expressions for flip-flop inputs. [3 pts]

(d) Draw the resulting logic circuit that implements this FSM. [2 pts]

Note: Please find flip-flop excitation tables attached in the last page.

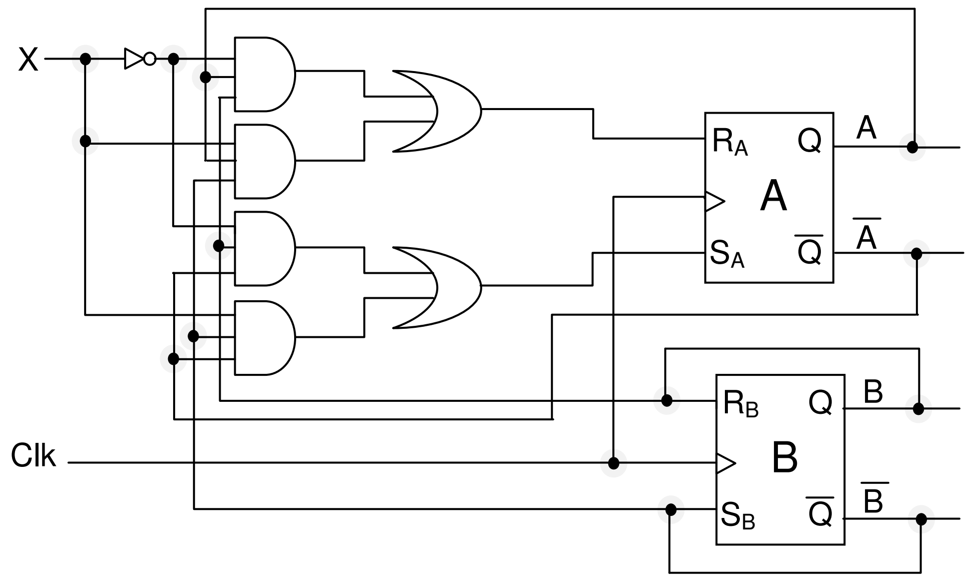
5.- The following circuit contains two RS flip-flops.

(a) Write the logic expressions for R_A, S_A, R_B and S_B. [2 pts]

(b) Obtain the state transition table for the circuit. [3 pts]

(c) Sketch the state transition diagram for the circuit. [2 pts]

(d) Compare RS and JK flip-flops, relationship and advantage of one type over the other in light of the results obtained for this question and question 4 above. [3 pts]



Excitation Table

Q	Q+	R	S	J	K	T	D
0	0	X	0	0	X	0	0
0	1	0	1	1	X	1	1
1	0	1	0	X	1	1	0
1	1	0	X	X	0	0	1

Basic Boolean Identities

	Identity	Comments
1.	$A+0=A$	Operations with 0 and 1
2.	$A+1=1$	Operations with 0 and 1
3.	$A+A=A$	Idompotent
4.	$A+\overline{A}=1$	Complementarity
5.	$A\cdot 0=0$	Operations with 0 and 1
6.	$A\cdot 1=A$	Operations with 0 and 1
7.	$A\cdot A=A$	Idompotent
8.	$A\cdot\overline{A}=0$	Complementarity
9.	$\overline{\overline{A}}=A$	Involution
10.	$A+B=B+A$	Commutative
11.	$A\cdot B=B\cdot A$	Commutative
12.	$A+(B+C)=(A+B)+C=A+B+C$	Associative
13.	$A\cdot(B\cdot C)=(A\cdot B)\cdot C=A\cdot B\cdot C$	Associative
14.	$A\cdot(B+C)=(A\cdot B)+(A\cdot C)$	Distributive
15.	$A+(B\cdot C)=(A+B)\cdot(A+C)$	Distributive
16.	$A+(A\cdot B)=A$	Absorption
17.	$A\cdot(A+B)=A$	Absorption
18.	$(A\cdot B)+(\overline{A}\cdot C)+(B\cdot C)=(A\cdot B)+(\overline{A}\cdot C)$	Consensus
19.	$\overline{A+B+C+\ldots}=\overline{A}\cdot\overline{B}\cdot\overline{C}\cdot\ldots$	De Morgan
20.	$\overline{A\cdot B\cdot C\cdot\ldots}=\overline{A}+\overline{B}+\overline{C}+\ldots$	De Morgan
21.	$(A+\overline{B})\cdot B=A\cdot B$	Simplification
22.	$(A\cdot\overline{B})+B=A+B$	Simplification