ELEC 2607 ('14) **Midterm** Duration: 1hr 30 mins 80 Marks

Answer all questions. Write your answers in the space provided on the question paper. Anything written on the reverse side won't be marked.

Authorized Memoranda: Closed book exam. Calculators are NOT allowed.

Name:

Student No.:

Section:

Instructors
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Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total
Marks											

1. Answer the following multiple-choice questions by **circling** the most appropriate answer from the given choices. Your performance on this question will also be used to evaluate the achievement of the graduate attribute 'Knowledge Base' in your degree program.

20 marks

(a) Which of the following statements is true of an AND gate?

i. The output of the AND gate is one if any one of its input terminals is set to 1.
ii. The output of the AND gate is one if both its input terminals are set to 1.
iii. The output of the AND gate is one if both its input terminals are set to 0.

(b) Which of the following statements about an XOR gate is true?

i. An XOR gate can be used as a controlled-inverter.
ii. An XOR gate is used to check even-parity.
iii. An XOR gate is obtained by inverting the output of an OR gate.

(c) Which of the following statements about a buffer is most appropriate?

i. A buffer inverts an input fed to it to generate its output.
ii. A buffer passes its input unmodified to its output.
iii. A buffer is implemented using two inverters connected in parallel.

(d) What is the idempotent law?

i. $X \cdot X = X$
ii. $X + \bar{X} = 1$
iii. $\bar{\bar{X}} = X$

(e) Which one of the following identities is associated with the distributive law?

i. $A + (B + C) = (A + B) + C$
ii. $A \cdot (B \cdot C) = (A \cdot B) \cdot C$
iii. $AB + C = (A + C)(B + C)$

(f) De Morgan's Law states that

i. $\overline{AB} = \bar{A} + \bar{B}$
ii. $\bar{A}\bar{B} = \overline{AB}$
iii. $\overline{\bar{A} + \bar{B}} = A + B$

(g) When working with binary numbers and computers the word 'nibble' means a collection of

i. 2 bits
ii. 4 bits
iii. 8 bits

(h) BCD stands for

i. Boolean Coded Decimal
ii. Binary Coded Decimal
iii. Boolean Computed Decimal

(i) When performing addition using two numbers represented by the 2's complement notation an overflow is detected when

i. there is a carry bit generated

ii. the most significant bits of the two numbers being added are the same and the most significant bit of the sum is different

iii. the most significant bits of the two numbers being added are equal to the most significant bit of the sum

(j) The two's complement of a binary number N with n digits is

i. $2^n - N$

ii. obtained by inverting all the bits in the binary number and subtracting 1 from it.

iii. obtained by inverting all the bits of the 1's complement of the binary number

(k) In a K-Map how many 1's can be looped together when they occur together

i. 8 ones

ii. 6 ones

iii. 10 ones

(l) In digital circuits '1' and '0' are usually represented by

i. Voltages

ii. Currents

iii. Energy Levels

(m) Parity is used in

i. adding two numbers

ii. finding the inverse of an expression

iii. detecting data transmission errors

(n) Which sentence is true when comparing AND-OR circuits with NAND-NOR circuits

i. NAND-NOR circuits are easier to design

ii. AND-OR circuits are easier to implement

iii. NAND-NOR circuits are easier to implement

(o) An important precaution while finding the dual of a function is to bracket this type of operation

i. NAND

ii. AND

iii. OR

(p) A number system with base 'b' has

i. b+1 unique symbols

ii. b unique symbols

iii. b-1 unique symbols

(q) A decimal number consisting of an integer- and fractional-part is converted to binary by performing

i. successive divisions on the integer and successive multiplications on the fraction

ii. successive divisions on the fraction and successive multiplications on the integer

iii. successive divisions

(r) In 2's complement system with n bits one may express the numbers

i. $-2^n + 1$ to $+2^n$

ii. -2^n to $+2^n$

iii. -2^n to $+2^n - 1$

(s) K-Maps are mainly used to

i. invert a function

ii. take the dual of a function

iii. obtain a simplified function

(t) The basic strategy is using K-Maps is to

i. use larger loops and lower number of loops

ii. use smaller loops and higher number of loops

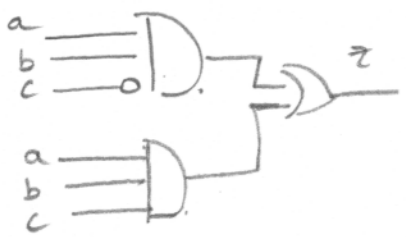
iii. use larger loops and larger number of loops

2. Can $\overline{a \oplus b \oplus c}$ be written as $\bar{a} \oplus b \oplus c$. Justify your answer. 6 Marks

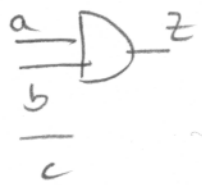
Yes. $\bar{a} \oplus b \oplus c = \bar{a} \oplus d$ where $d = b \oplus c$

$\bar{a} \oplus d = \overline{a \oplus d} = \overline{a \oplus b \oplus c}$

3. Design a logic gate or circuit that generates an output z which goes to '1' only if the inputs abc are '110' or '111'. 4 Marks



or



4. Convert the expression $\overline{a\bar{b} + bc + c\overline{(de + g)}}$ to a form where the bars are only over single variables. 4 Marks

$\overline{\{a\bar{b}\} + \{bc\} + \{c(\bar{d}+\bar{e})\bar{g})\}}$.

$= (\bar{a} + b)(\bar{b}+\bar{c})(\bar{c}+g+de)$

5. Find simplified expressions for the following K-Maps. 6 Marks

$f(a,b,c)$

0	1	d	d
1	0	1	d

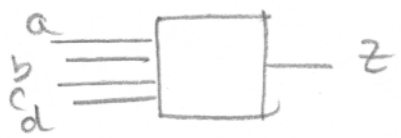
$g(a,b,c,d)$

1	1	d	1
d	1	d	0
0	d	1	0
1	0	0	0

$f(a,b,c) =$ $a + b\bar{c} + \bar{b}c$

$g(a,b,c) =$ $bd + \bar{a}\bar{b} + \bar{b}\bar{d}\bar{c}$

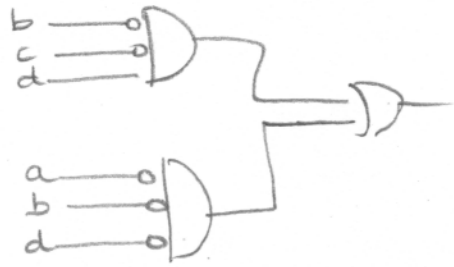
6. *abcd* is a Binary Coded Decimal (BCD) digit. Design a circuit which takes *abcd* as its input and outputs a '1' if the digit is less than 3 and greater than 8. 7 Marks



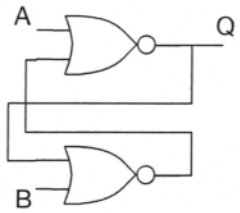
z is 1 if abcd < 3
or abcd > 8.

ab \ cd	00	01	11	10
00	1	1		1
01				
11	d	d	d	d
10		1	d	d

$z = \bar{b}\bar{c}d + \bar{a}\bar{b}\bar{d}$



7. Consider the following circuit. 6 Marks



A	B	Q
0	0	$\hat{Q}$
0	1	1
1	0	0
1	1	0

(a) Fill out the truth table above for the circuit. You may use $\hat{Q}$ as the previous value of Q and use it in the table.

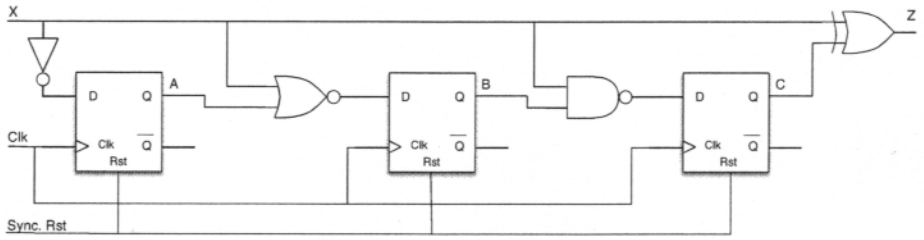
(b) This should be a component familiar to you. What is the name of the component? What are the appropriate names for inputs A and B?

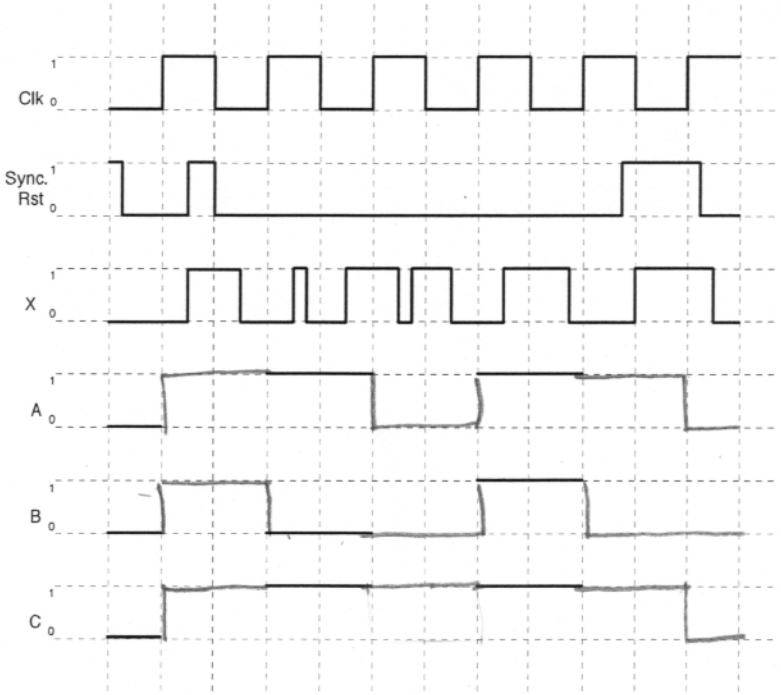
It's an S-R latch. A is R for reset and B is S for set

(c) Which one of A and B has priority over the other input in determining the output value?

A has priority over B.

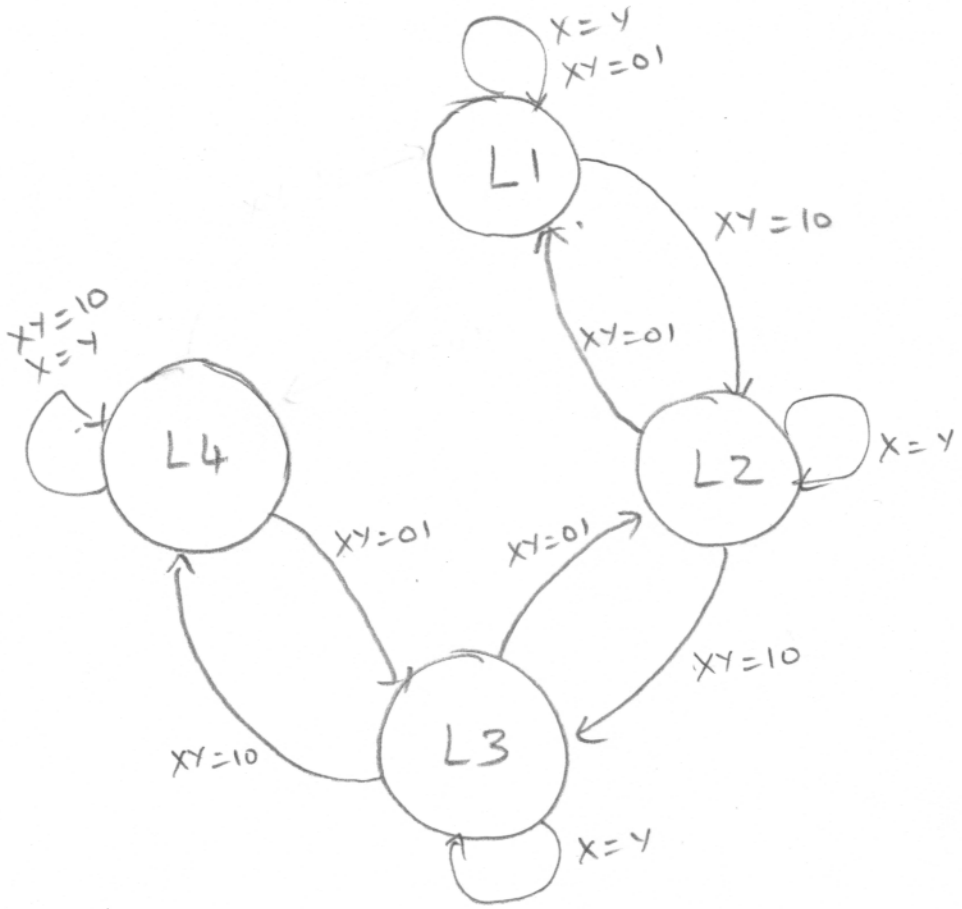
8. Complete the timing diagram for the circuit shown below. 9 Marks



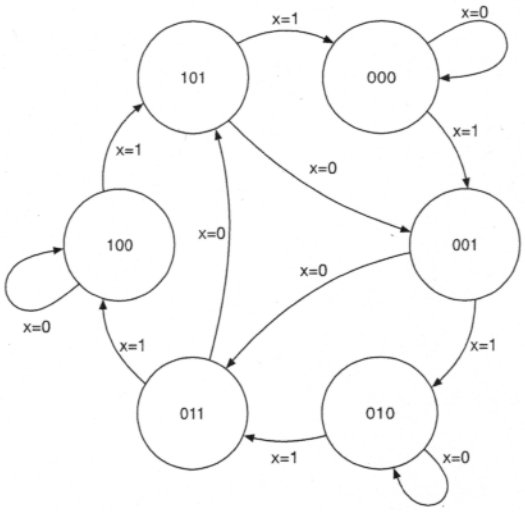


9. Draw the state graph (only) of an FSM for a lift that takes the material and the personnel up and down through the levels of a 4-story building under construction. The lift is only controllable from the ground by two switches X and Y. If X=Y, the lift doesn't move. If XY=10, the lift goes one level up, except when it is already at the highest level. If XY=01, the lift goes down one level, except when it is already at the ground. Let the FSM state indicate the current lift position (i.e. level).

6 Marks

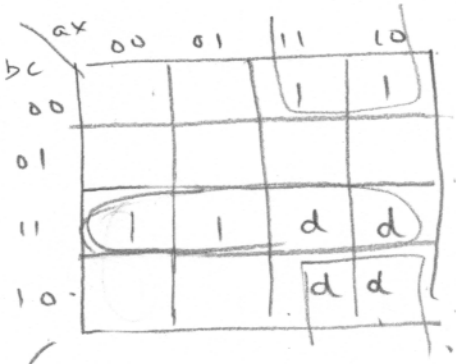


10. Implement the following state-graph as a circuit. Show your K-Maps and the final circuit. Assume that the FSM will not visit unused states under any circumstance. 12 Marks

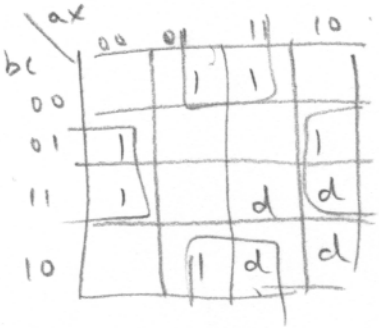


abc	$a^+ b^+ c^+$ x=0	x=1
000	000	001
001	011	010
011	101	100
010	010	011
100	100	101
101	001	000
111	ddd	ddd
110	ddd	ddd

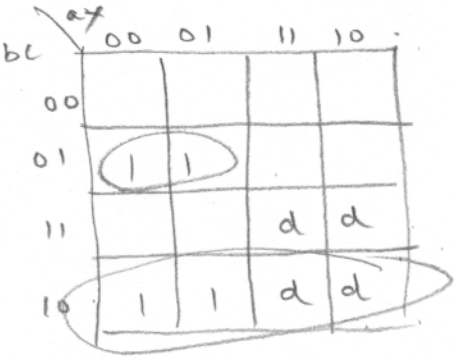
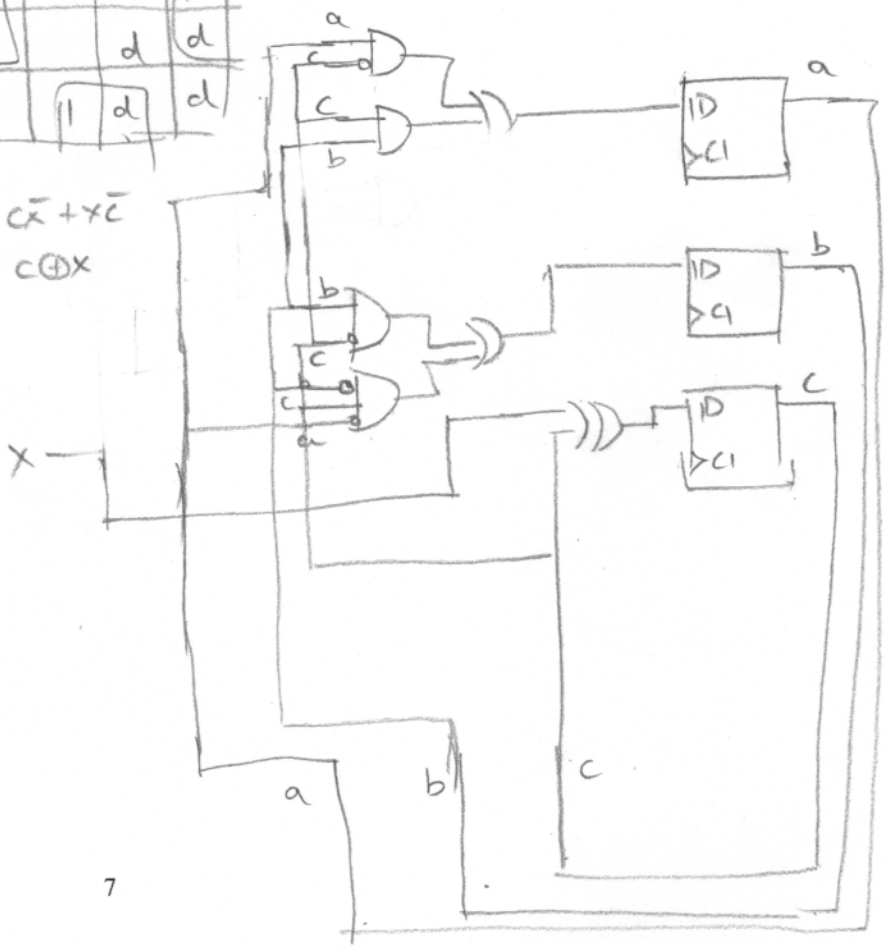
bc \ ax	00	01	11	10
00	000	001	101	100
01	011	010	000	001
11	101	100	ddd	ddd
10	010	011	ddd	ddd



$a^+ = a\bar{c} + cb$



$c^+ = c\bar{x} + x\bar{c}$
$= c \oplus x$



$b^+ = b\bar{c} + \bar{b}c\bar{a}$