COMP 231-01
Introduction to Computer Organization
Exam Review

Rhodes College
—1848—

- Answer the following questions:

1. Convert the following to base-10:

   A 21_3 **7**
   B 371_{17} **987**
   C 100111_2 **39**
   D 52_6 **32**
   E FB_{16} **251**
   F 71_9 **64**
   G $1B1_{16}$ **433**
   H 11_2 **3**

2. Convert the following from decimal notation to the corresponding base:

   A 533 to base 2 **1000010101**
   B 2062 to base 2 **100000001110**
   C 12 to base 2 **1100**
   D 243 to base 16 **F3**
   E 27 to base 16 **1B**
   F 5000 to base 16 **1388**
   G 11 to base 5 **21**
   H 66 to base 3 **2110**

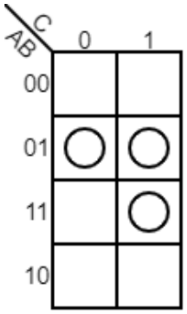
3. Convert the following from decimal to 8-bit 2's complement:

   A -100 **11100100**
   B 32 **00100000**
   C -57 **11000111**
   D 67 **01000011**
   E -128 **10000000**
   F 128 **Undefined! Out of bounds for 8-bit 2's complement**

4. Perform the following operations using 4-bit 2's complement signed arithmetic:

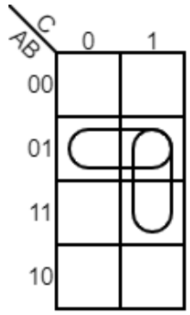
   A $0110 + 1001$ **1111**
   B $1010 + 0011$ **1101**
   C $1110 + 0101$ **0011 carry out = 1**
   D $1100 + 0111$ **0011 carry out = 1**
   E $1011 - 1001$ **1011 + 0111 = 0010 carry out = 1**
   F $0011 - 0010$ **0011 + 1110 = 0001 carry out = 1**
   G $1001 - 0011$ **1001 + 1101 = 0110 carry out = 1**
   H $0001 - 0110$ **0001 + 1111 = 0000 carry out = 1**

5. Consider the boolean algebra expression $F = \bar{A} * B + A * B * C$. Create a k-map for this expression and use the k-map to derive the MSOP (minimal sum of products).



X are Don't Care tiles.
O are normal tiles. AKA 1

KMap



Boolean Algebra

$\overline{A}B+BC$

Truth Table

A	B	C	Output
0	0	0	F
0	0	1	F
0	1	0	T
0	1	1	T
1	0	0	F
1	0	1	F
1	1	0	F
1	1	1	T

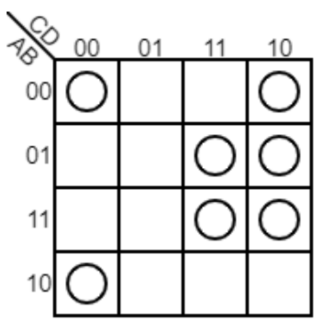
6. Consider the boolean algebra expression $F = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}C\bar{D} + \bar{A}BC\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + ABC\bar{D} + ABCD$. Create a k-map for this expression and use the k-map to derive the MSOP (minimal sum of products).

Boolean Algebra

$BC+\overline{B}\overline{C}\overline{D}+\overline{A}\overline{B}\overline{D}$

Truth Table

A	B	C	D	Output
0	0	0	0	T
0	0	0	1	F
0	0	1	0	T
0	0	1	1	F
0	1	0	0	F
0	1	0	1	F
0	1	1	0	T
0	1	1	1	T
1	0	0	0	T
1	0	0	1	F
1	0	1	0	F
1	0	1	1	F
1	1	0	0	F
1	1	0	1	F
1	1	1	0	T
1	1	1	1	T



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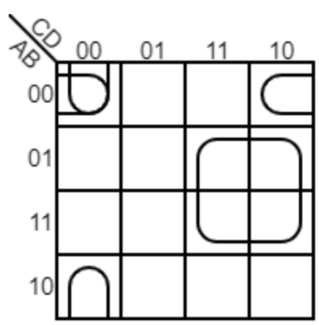
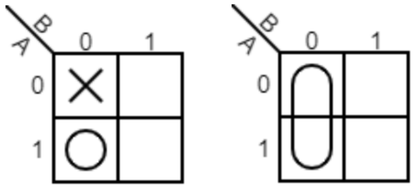
KMap



7. Create a truth table, a MSOP boolean algebra expression, and draw a circuit for a function that takes in two variables and returns 1 if the function is even and 0 if the function is odd. (For this situation, we don't care whether a zero is evaluated as even or odd.) **For this problem, use only and gates, or gates, and not gates.**

KMap



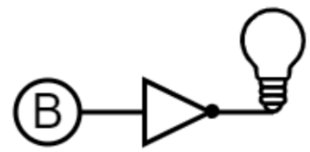
Boolean Algebra

$\overline{B}$

Truth Table

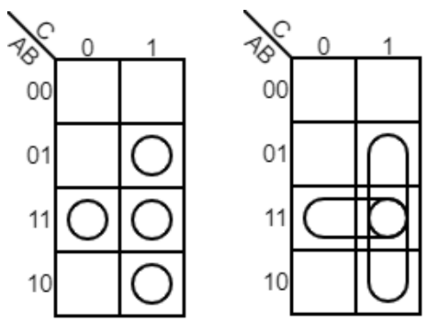
A	B	Output
0	0	T
0	1	F
1	0	T
1	1	F

Logic Gate



8. Create a truth table, a MSOP boolean algebra expression, and draw a circuit for a function that takes in three variables and returns 1 only if two of the inputs are 1. **For this problem, use only and gates, or gates, and not gates.**

KMap

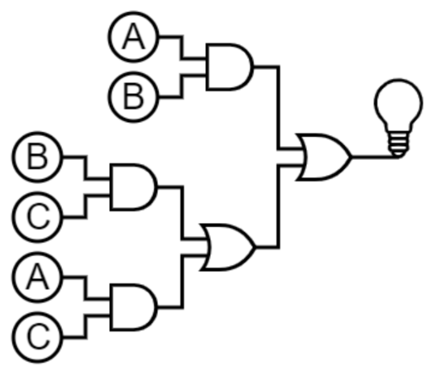


Boolean Algebra

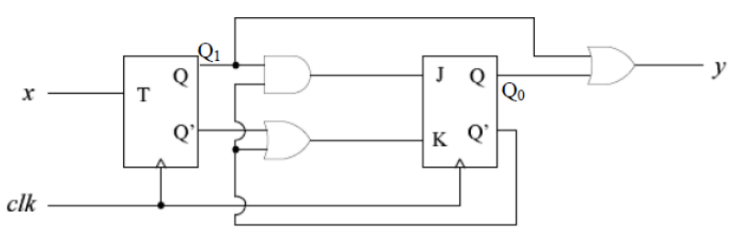
AB+BC+AC

Truth Table

A	B	C	Output
0	0	0	F
0	0	1	F
0	1	0	F
0	1	1	T
1	0	0	F
1	0	1	T
1	1	0	T
1	1	1	T

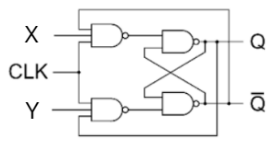


9. Consider the following circuit, with a T flipflop and a JK flip flop. Create a characteristic table that shows what the next state will be for this circuit.



X Q_1 Q_0	$Q_1(t+1)$ $Q_0(t+1)$
0 0 0	0 1
0 0 1	0 1
0 1 0	1 1
0 1 1	1 0
1 0 0	1 1
1 0 1	1 1
1 1 0	0 1
1 1 1	0 0

10. Consider the following circuit. What is the characteristic table for its output?



That of a JK flipflop; this is how a JK is implemented!
J K | Q
0 0 | Q
0 1 | 0
1 0 | 1
1 1 | $\bar{Q}$

11. What is the use of a half adder? In what situation would this be used?
    The half adder adds two inputs together. This would be used if you're adding the first digit of a number.

12. What is the characteristic table for the D flipflop?
    D = 0, Q = 0
    D = 1, Q = 1

13. Why is state S=1 R=1 undefined for an SR flipflop?
    Because the transition to S=0 R=0 results in a race condition and undefined behavior. Also because it violates our rule that Q and $\bar{Q}$ are opposites.

14. Is this 64-bit signed 2's complement number positive or negative?
    1000011000101110111101001111100011101001111001100001101101010101
    Negative, from the first bit.

15. What is the purpose of a multiplexer?
    It toggles between different data streams based on a set of switches, allowing each data input access to the circuit or device.

16. What is the range of 8-bit signed 2's complement?
    -128 to +127

17. What is the difference between 1's complement and 2's complement?
    In 2's complement, you add 1 to the result of 1's complement

18. What is a decoder used for in an ALU?
    It is used to select which operation is run.

19. How do we implement memory in our circuits?
    We use flip flops to incorporate the idea of memory (feedback). They can be used to store values even from previous clock cycles.

20. What is the disadvantage of a ripple-carry adder?
    A ripple carry-adder needs time for all the bits to calculate their carry out, each of which depends on the previous bit. This can produce incorrect results if the value is read before the carry out values have propogated all the way through.