Points missed: _____ Student's Name: _________________________________

Total score: _____ /100 points

East Tennessee State University
Department of Computer and Information Sciences
CSCI 2150 (Tarnoff) – Computer Organization
TEST 2 for Spring Semester, 2005

Section 001

Read this before starting!

- The total possible score for this test is 100 points.
- This test is closed book and closed notes.
- **All** answers **must** be placed in space provided. Failure to do so may result in loss of points.
- **1 point** will be deducted per answer for missing or incorrect units when required. **No** assumptions will be made for hexadecimal versus decimal, so you should always include the base in your answer.
- If you perform work on the back of a page in this test, indicate that you have done so in case the need arises for partial credit to be determined.
- ***Calculators are not allowed.*** Use the tables below for any conversions you may need. Leaving numeric equations is fine too.

Binary	Hex
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7

Binary	Hex
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

Power of 2	Equals
2^3	8
2^4	16
2^5	32
2^6	64
2^7	128
2^8	256
2^9	512
2^{10}	1K
2^{20}	1M
2^{30}	1G

"Fine print"

Academic Misconduct:

Section 5.7 "Academic Misconduct" of the East Tennessee State University Faculty Handbook, June 1, 2001:

"Academic misconduct will be subject to disciplinary action. Any act of dishonesty in academic work constitutes academic misconduct. This includes plagiarism, the changing of falsifying of any academic documents or materials, cheating, and the giving or receiving of unauthorized aid in tests, examinations, or other assigned school work. Penalties for academic misconduct will vary with the seriousness of the offense and may include, but are not limited to: a grade of 'F' on the work in question, a grade of 'F' of the course, reprimand, probation, suspension, and expulsion. For a second academic offense the penalty is permanent expulsion."

Short answers – 2 points each

1. True or False: The expression $A \cdot \overline{B} \cdot C + \overline{B} \cdot \overline{C} + \overline{A}$ is in proper Sum-of-Products format.
2. True or False: Every truth table can be realized with both a Sum-of-Products expression and a Product-of-Sums expression.
3. True or False: There exists exactly one pattern of rectangles for every pattern of 1's and 0's in a Karnaugh map.
4. How many cells does a 4 input Karnaugh map have?

   a.) 4 b.) 6 c.) 8 d.) 16 e.) 24 f.) 32

5. What is the largest number of input variables a Karnaugh map can have and remain 2-dimensional?

   a.) 3 b.) 4 c.) 5 d.) 6 e.) 7 f.) 8

6. In a 4-variable Karnaugh map, how many input variables (A, B, C, or D) does a product have if its rectangle of 1's contains 4 cells?

   a.) 1 b.) 2 c.) 3 d.) 4 e.) Cannot be determined

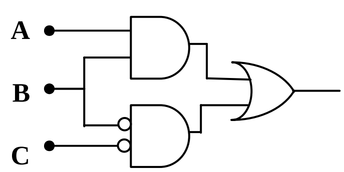
7. An active-low transparent latch copies data from the D input to the Q output when the clock is:

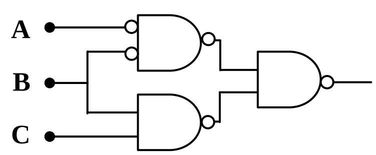
   a.) a logic 0 c.) changing from a 1 to a 0 b.) a logic 1 d.) changing from a 0 to a 1

8. The invalid state of the active-low S-R latch occurs when the inputs are:

   a.) $\overline{S} = 0, \overline{R} = 0$ b.) $\overline{S} = 0, \overline{R} = 1$ c.) $\overline{S} = 1, \overline{R} = 0$ d.) $\overline{S} = 1, \overline{R} = 1$

9. True or False: The two circuits below are equal.





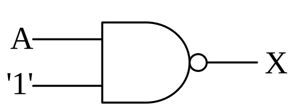
10. True or False: The result of the application of a Karnaugh map is a ***minimum*** SOP expression.
11. True or False: In a 3-input Karnaugh map, the maximum number of rectangles to cover all of the ones of any pattern of ones is 4. (Hint: try to find an example that requires more rectangles.)
12. True or False: The $\overline{S}$ and $\overline{R}$ inputs to a D-latch have priority over the D and clock inputs.
13. Which of the following products produces the truth table to the right?

   a.) $A \cdot B \cdot \overline{C}$ b.) $\overline{A} \cdot \overline{B} \cdot C$ c.) $A \cdot \overline{B} \cdot C$
   c.) $A \cdot B \cdot C$ d.) $\overline{A} \cdot B \cdot \overline{C}$ d.) None of the above

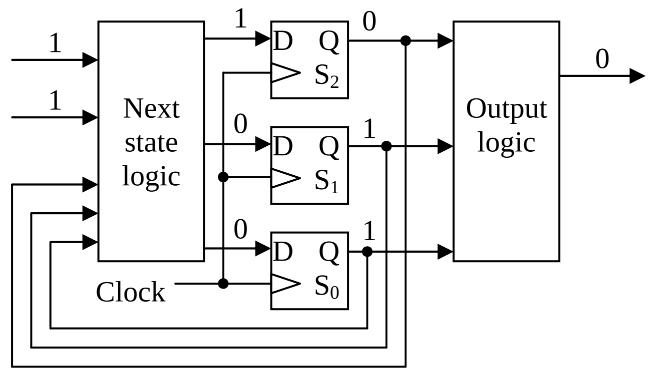
A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

14. Fill in the truth table for the NAND circuit shown below.

A	X



The next four problems use the state machine diagram to the right. Assume that the states are numbered so that bit S_2 is the MSB and bit S_0 is the LSB.



15. How many rows does the next state truth table have for this system?

16. How many rows does the output truth table for this system have?

17. What is the current state of this system? Keep your answer in binary.

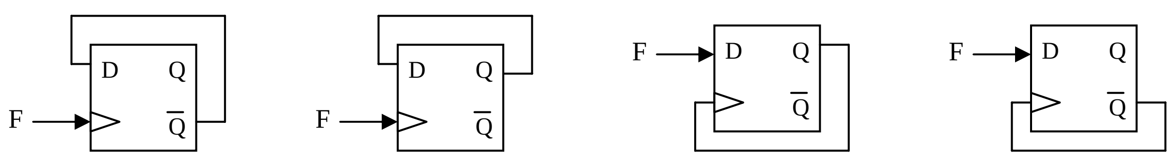
18. If the clock were to pulse right now, what would the next state be? Keep your answer in binary.

19. True or False: Renumbering the states of a state machine has no effect on the "next state" logic for the digital hardware implementation.

20. How many latches will a state machine with 16 states require?

a.) 1 b.) 2 c.) 3 d.) 4 e.) 5 f.) 6 g.) 7

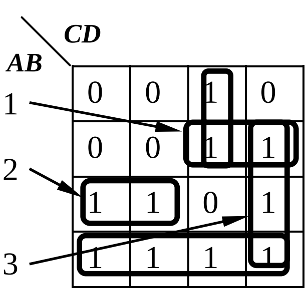
21. Place a circle around the circuit below that can be used to divide the ***frequency*** of the input F by 2.



22. In a truth table, the symbol ↓ represents an input that is:

a.) a logic 0
b.) a logic 1
c.) changing from a 1 to a 0
d.) changing from a 0 to a 1
e.) this is an output symbol, not an input
f.) a "don't care"

23. For the Karnaugh map to the right, identify the problems with each of the three rectangles shown. (2 points each)



Rectangle 1:

Rectangle 2:

Rectangle 3:

Medium answers – 4 points each

24. Complete the truth table to the right with the values for the following Sum-of-Products expression:

$$X = (\overline{A} \cdot \overline{B} \cdot C) + (\overline{A} \cdot B) + (A \cdot \overline{B} \cdot \overline{C})$$

A	B	C	X
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

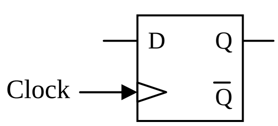
25. Create a Karnaugh map from the truth table below. ***Do not worry about making the rectangles.***

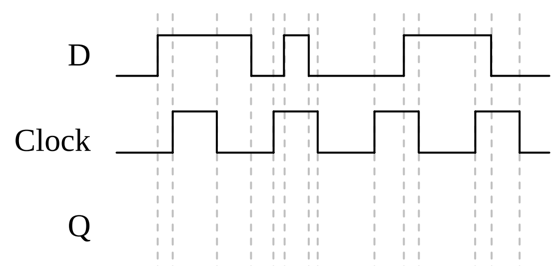
A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

26. In the Karnaugh map to the right, draw the best pattern of rectangles you can. ***Do not derive the SOP expression.***

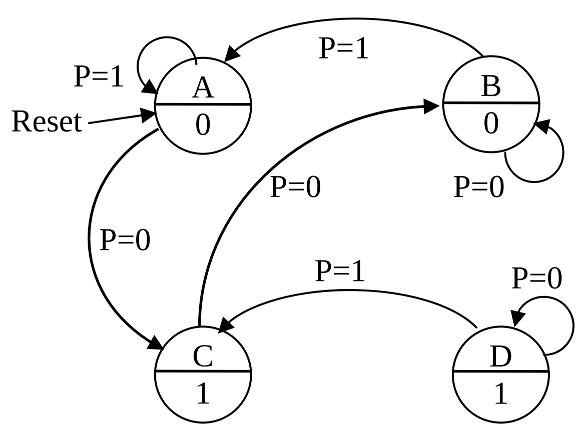
AB* \ *CD	00	01	11	10
00	1	0	0	1
01	0	0	1	1
11	0	1	1	1
10	1	0	0	1

27. Show the *D* latch output waveform *Q* based on the inputs *D*, $\overline{S}$, $\overline{R}$, and clock indicated in the graph to the right. Assume the latch captures on the falling edge. (The figure below is just for a reference.)





28. Identify the ***two*** errors in the state diagram shown to the right.

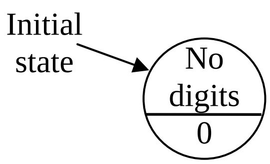


Longer answers – Points vary per problem

29. Make the state diagram that will output a '1' when the sequence '110' is detected in a serial stream of bits. For example, if the following binary stream is received:

`1 1 1 0 0 1 1 1 1 1 0 0 1 1 0 0 1 0 0 1 1 0 1 0 0 0 1 0`

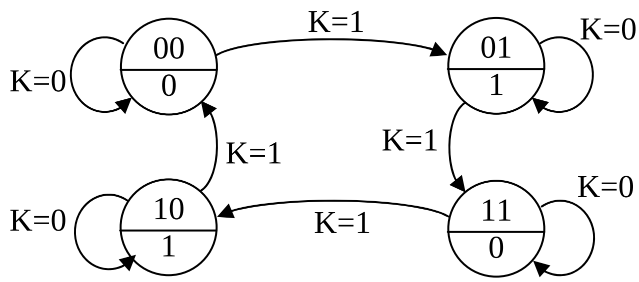
then 1's will be output here. Otherwise, the system will output zeros. Label the input D. (8 points)



30. Derive the minimum SOP expression from the Karnaugh map below. (6 points)

AB* \ *CD	00	01	11	10
00	0	0	0	0
01	0	1	1	1
11	1	1	1	1
10	1	1	1	1

31. Create the next state truth table and the output truth table for the state diagram to the right. Use the variable names S_1 and S_0 to represent the most significant and least significant bits respectively of the binary number identifying the state. (8 points)



32. The three Boolean expressions below represent the ***next state bits (S_0' and S_1')*** and the ***output bit X*** based on the ***current state (S_0 and S_1)***. Draw the logic circuit for the state machine including the latches and output circuitry. Be sure to label the latch inputs and other signals.
(8 points)

$S_0' = \overline{S_1}$ $\quad$ $S_1' = \overline{S_0}$ $\quad$ $X = S_1 \cdot S_0$