

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, 2006

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:

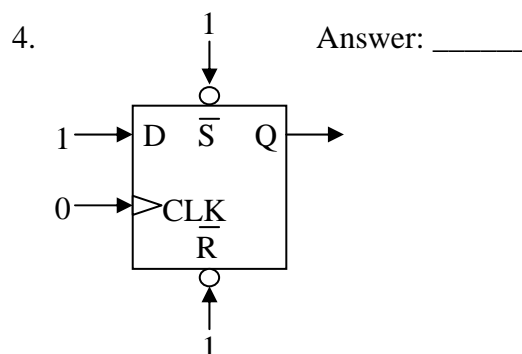
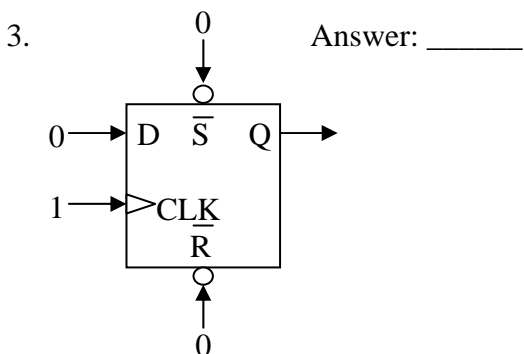
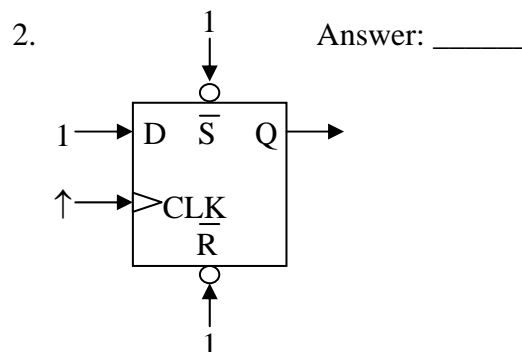
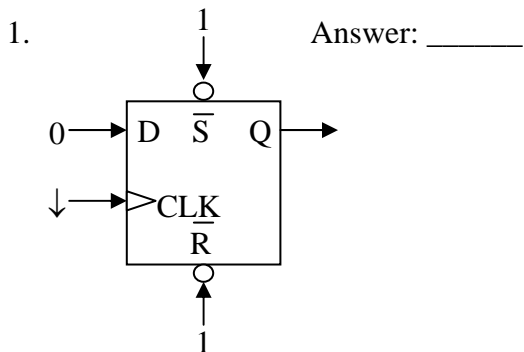
Section 5.7 "Academic Misconduct" of the East Tennessee State University Faculty Handbook, June 1, 2001:

"Academic misconduct will be subject to disciplinary action. Any act of dishonesty in academic work constitutes academic misconduct. This includes plagiarizing, the changing or 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

For the following **four** circuits, identify the value of the output Q from the following choices.
Consider the D-latch a **rising edge triggered latch**.

- a.) 1 b.) 0 c.) Q_0 (stored value of Q) d.) undefined/illegal e.) can't tell

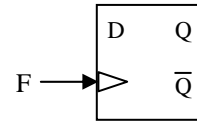


5. True or False: The expression $(\bar{A} + B + C) \cdot (B + C) \cdot (\bar{A} + \bar{B})$ is in proper Product-of-Sums format.
6. In the space to the right, give an example of a 3-input Karnaugh map where more than one pattern of rectangles exists for the same arrangement of 1's and 0's.
7. True or False: In a Karnaugh map, there must be an adjacent cell for every possible single-variable change. For example, if a Karnaugh map has three input variables, then there must be three cells adjacent to every cell in the map where only one variable value changes in a move to that cell.
8. How many cells does a 2 input Karnaugh map have?
a.) 2 b.) 4 c.) 6 d.) 8 e.) 16 f.) 24 g.) 32
9. In a 4-variable Karnaugh map, how many input variables (A, B, C, or D) does a product have if its corresponding rectangle of 1's contains 4 cells?
a.) 1 b.) 2 c.) 3 d.) 4 e.) Cannot be determined

10. An active-low transparent latch copies data from the D input to the Q output:
- a.) as long as the clock equals a logic 0
 - b.) the instant the clock changes from a 1 to a 0
 - c.) as long as the clock equals a logic 1
 - d.) the instant the clock changes from a 0 to a 1

11. True or False: The D-latch is built around the S-R latch, and therefore, every D-latch contains within it an S-R latch.

12. Make the connections to the latch in the figure to the right that makes a divide-by-two circuit, i.e., divides the frequency F in half at the output Q.

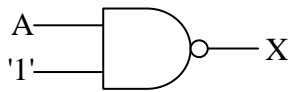


13. Which of the following expressions produces the truth table to the right?

- a.) $A + C$
- b.) $A + \bar{B}$
- c.) $A + \bar{B} + C$
- d.) $\bar{B} \cdot C$
- e.) $A + \bar{B} \cdot C$
- f.) None of the above

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

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

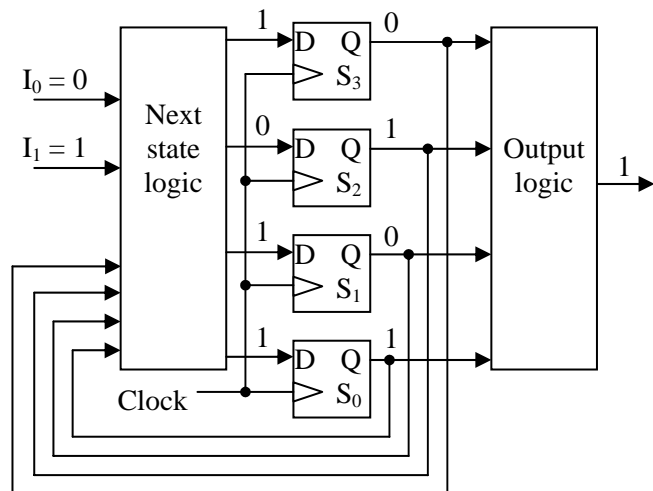


A	X

The next five problems use the state machine diagram to the right. Assume that the states are numbered so that bit S_3 is the MSB and bit S_0 is the LSB.

15. What is the maximum number of states that this system can handle?

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



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

18. If the input I_1 changed from 1 to 0, but everything else remained unchanged, the output of the system would remain unchanged.

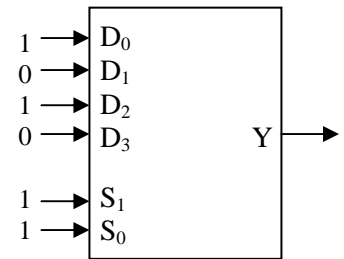
- a.) True
- b.) False
- c.) Not enough information given

19. If the input I_1 changed from 1 to 0, but everything else remained unchanged, the next state that the system would go to after a clock pulse would remain unchanged.

- a.) True
- b.) False
- c.) Not enough information given

20. True or False: Renumbering the states of a state machine has no effect on the "next state" logic for the digital hardware implementation.
21. How many latches will a state machine with 65 states require?
 a.) 3 b.) 4 c.) 5 d.) 6 e.) 7 f.) 8 g.) 9
22. If a group of four rows or columns in a Karnaugh map is identified with two variables, it is numbered 00, 01, 11, 10 instead of 00, 01, 10, 11. Why?

23. For the multiplexer/selecter shown to the right, what is the output Y?

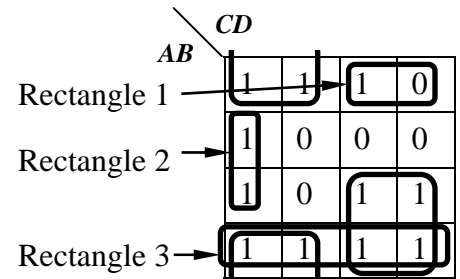


24. For the Karnaugh map to the right, identify the problems with each of the three rectangles shown. (2 points each)

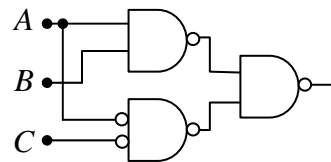
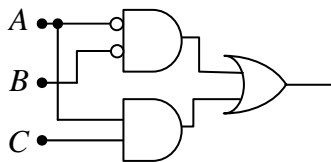
Rectangle 1:

Rectangle 2:

Rectangle 3:



25. True or false: The two circuits below are equivalent.



Medium answers – 4 points each

26. Complete the truth table to the right with the values for the following Product-of-Sums expression:

$$(A + B + \bar{C}) \cdot (A + C) \cdot (\bar{A} + B)$$

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	

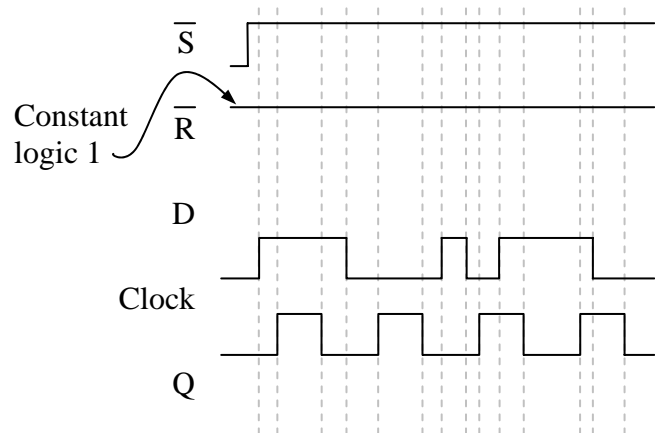
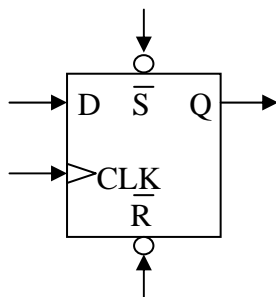
27. In the Karnaugh map to the right, draw the best pattern of rectangles you can. **Do not derive the SOP expression.**

		CD			
		00	01	11	10
AB	00	1	1	1	1
	01	X	X	0	0
	11	0	1	0	0
	10	1	1	1	1

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

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

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

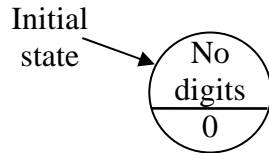


Longer answers – Points vary per problem

30. Make the state diagram that will output a '1' when the sequence '111' is detected in a serial stream of bits. For example, if the following binary stream is received:

0 0 **1 1 1** 0 1 0 1 0 **1 1 1 1** 0 0 0 0 1 1 0 **1 1 1** 0 0 1 1

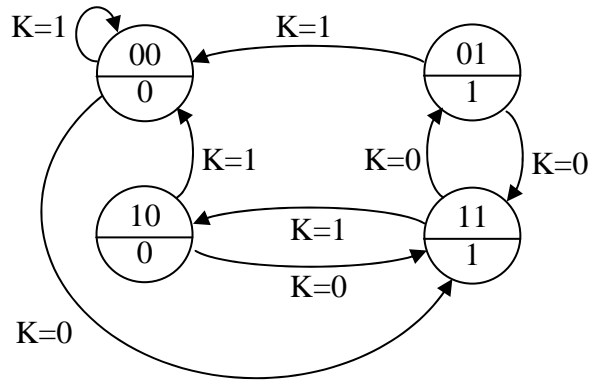
then 1's will be output at these points. (Notice that the last two ones of the second pattern are shared with the first two ones of the third pattern.) At all other times, the system will output zeros. Label the input D. (8 points)



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

	<i>CD</i>			
	00	01	11	10
<i>AB</i>				
00	1	1	1	1
01	0	0	1	1
11	0	0	1	1
10	0	0	1	0

32. 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. Label the output 'X'. (8 points)



33. 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) and the *input* A . 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)

$$S_0' = \bar{S}_1 \bar{S}_0$$

$$S_1' = A$$

$$X = S_1 + S_0$$