CS 202: Introduction to Computation
Fall 2011: Final Exam

You have a total of TWO (2) hours to complete the questions on this exam **AND** take the on-line AP pilot exam (if you have not taken the AP pilot exam yet).

This part of the exam has 12 pages and 80 questions.

The exam is Multiple Choice and True/False. For each question, you should mark only the single best answer (i.e., there is exactly one correct choice per question).

Use the green Scantron form to designate all of your answers. Fill in your Lastname, Firstname, and your Student Identification Number. Use a No. 2 pencil. We will collect this booklet at the end of the exam, but we will not grade any answers that you may mark in this book.

This exam is closed notes. Turn off all cell phones before the exam begins.

Notation: You can assume that log means $\log_2$ if not otherwise specified.

If you have not yet taken the AP pilot exam, you must begin it ONE hour before the end of this testing period. Your performance on the AP pilot exam will not be graded; we will only record whether or not you took the AP pilot exam.

Good luck!

Part 1: Do you know a little bit? [2 points each]
For each of the following questions #1-24, designate if the statement is True (a) or False (b).

1) The binary number 00110 is 6 in decimal.

2) The binary number 01001 is 7 in decimal.

3) The decimal number 5 is 000011 in binary.

4) The decimal number 13 is 001101 in binary.

5) The binary number 001100 has the same value as the binary number 1100.

6) Exactly 16 unique unsigned integers can be represented in 4 bits.

7) Exactly 31 unique unsigned integers can be represented in 5 bits.

8) Exactly $\log_2 N$ different unsigned integers can be represented in N bits.

9) The decimal integers 0 through 8 (inclusive) can all be represented with 3 bits.

10) The number 0111 has a higher value in base ten than in base two.

11) The number 0001 has a higher value in base ten than in base two.

12) The binary number 00101000 is evenly divisible by 2 (i.e., is an even number).

13) The binary number 01110111 is evenly divisible by 2 (i.e., is an even number).

14) The binary number 0010 divided by 2 (decimal) is 0001.

15) The binary number 01100 divided by 2 (decimal) is 00110.

16) The binary number 011001000 divided by 2 (decimal) is 001110100.

17) 4031 is a valid number in a base-4 representation.

18) 1007 is a valid number in a base-8 (octal) representation.

19) abcdef is a valid number in a base-16 (hexadecimal) representation.

20) In binary, 0101 + 1010 = 1111.

21) In binary, 0111 + 1000 = 1011.

22) In binary, 0111 + 0011 = 1010.

23) A complete truth table with 3 input variables should contain exactly 8 rows

24) A complete truth table with N input variables should contain exactly $N^2 - 1$ rows of values.

Part 2: Computing with Boolean Logic [5 points each]

For the following three questions #25 – 27, assume the Boolean function has two inputs (A and B) and one output (C). Match the shown truth table with its correct Boolean expression.

25)

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

a) C = (NOT A) AND (NOT B)
b) C = (NOT A) AND (B)
c) C = (A) AND (NOT B)
d) C = (A) AND (B)
e) None of the above

26)

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

a) C = (NOT A) AND (NOT B)
b) C = (NOT A) AND (B)
c) C = (A) AND (NOT B)
d) C = (A) AND (B)
e) None of the above

27)

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

a) C = (NOT A) AND (NOT B)
b) C = (NOT A) AND (B)
c) C = (A) AND (NOT B)
d) C = (A) AND (B)
e) None of the above

28) For this one question, assume you have a Boolean expression with three inputs (A, B, C) and one output (D). Match the shown truth table with its correct Boolean expression

A	**B**	**C**	**D**
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

a) D = ((NOT A) AND (NOT B) AND (NOT C))
OR
((A) AND (NOT B) AND (NOT C))
OR
((A) AND (NOT B) AND (C))

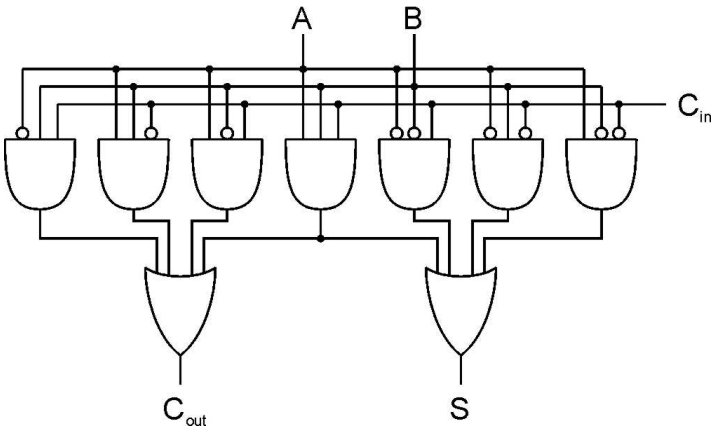
b) D = ((NOT A) AND (NOT B) AND (NOT C))
OR
((NOT A) AND (B) AND (C))
OR
((A) AND (B) AND (NOT C))

c) D = ((NOT A) AND (NOT B) AND (NOT C))
OR
((NOT A) AND (B) AND (C))
OR
((A) AND (NOT B) AND (C))

d) D = ((NOT A) AND (NOT B) AND (NOT C))
OR
((NOT A)
OR
((NOT B))

e) None of the above

For the following five questions (#29-33), consider the following implementation of a 1-bit full adder.



29) How many input variables are there to this circuit?
- a) Two
- b) Three
- c) Four
- d) Five
- e) None of the above

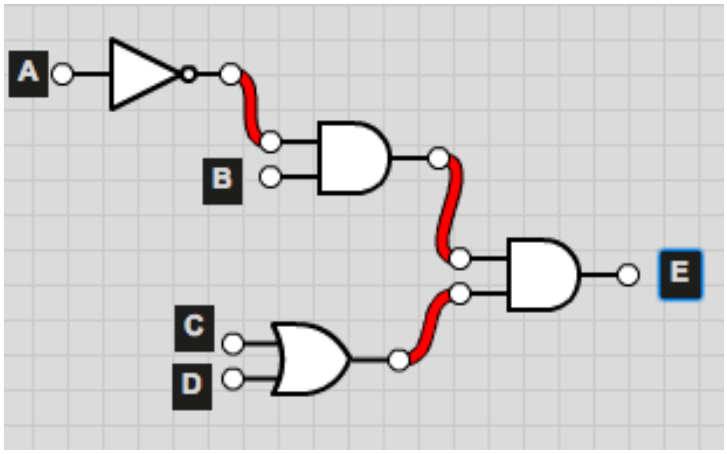
30) When A=1, B= 0, and Cin = 0, what will be the output values of Cout and S?
- a) Cout = 0, S = 0
- b) Cout = 0, S = 1
- c) Cout = 1, S = 0
- d) Cout = 1, S = 1
- e) None of the above

31) When A=1, B= 0, and Cin = 1, what will be the output values of Cout and S?
- a) Cout = 0, S = 0
- b) Cout = 0, S = 1
- c) Cout = 1, S = 0
- d) Cout = 1, S = 1
- e) None of the above

32) When A=1, B= 1, and Cin = 0, what will be the output values of Cout and S?
- a) Cout = 0, S = 0
- b) Cout = 0, S = 1
- c) Cout = 1, S = 0
- d) Cout = 1, S = 1
- e) None of the above

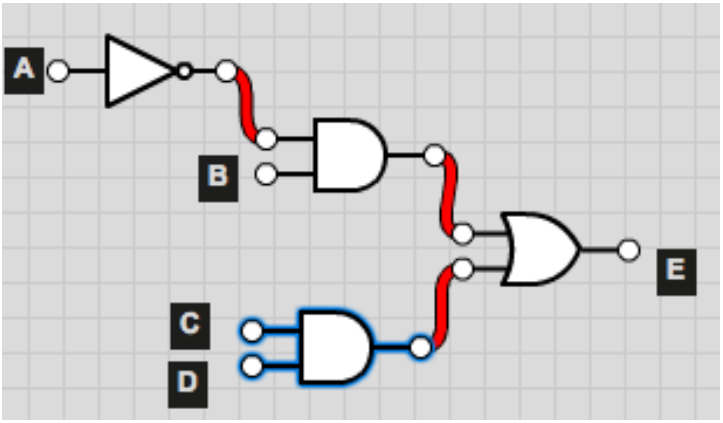
33) When A=1, B= 1, and Cin = 1, what will be the output values of Cout and S?
- a) Cout = 0, S = 0
- b) Cout = 0, S = 1
- c) Cout = 1, S = 0
- d) Cout = 1, S = 1
- e) None of the above

34) Which of the following Boolean expressions is equivalent to the hardware circuit shown below?



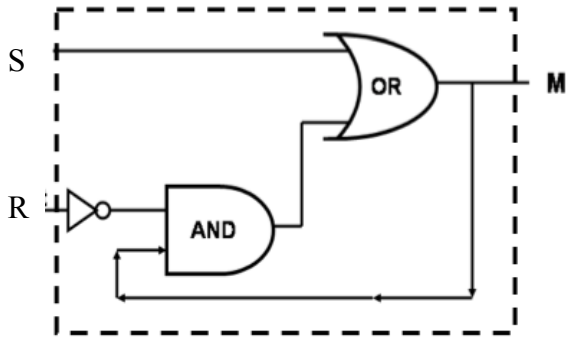
a) E = (((NOT A) AND B) AND C) OR (D)
b) E = NOT (A AND B) AND (C OR D)
c) E = ((NOT A) AND B) AND (C OR D)
d) E = ((NOT A) OR B) OR (C AND D)
e) None of the above.

35) Which of the following Boolean expressions is equivalent to the hardware circuit shown below?



a) E = (((NOT A) AND B) AND C) OR (D)
b) E = NOT (A AND B) AND (C OR D)
c) E = ((NOT A) AND B) AND (C OR D)
d) E = ((NOT A) OR B) OR (C AND D)
e) None of the above.

36) Which of the following Boolean expressions is equivalent to the hardware circuit shown below?



a) M = S OR (NOT R)
b) M = S OR ((NOT R) AND S)
c) M = S OR ((NOT R) AND M)
d) M = S OR ((NOT R) AND (S OR (NOT R))
e) M cannot be expressed using Boolean Logic.

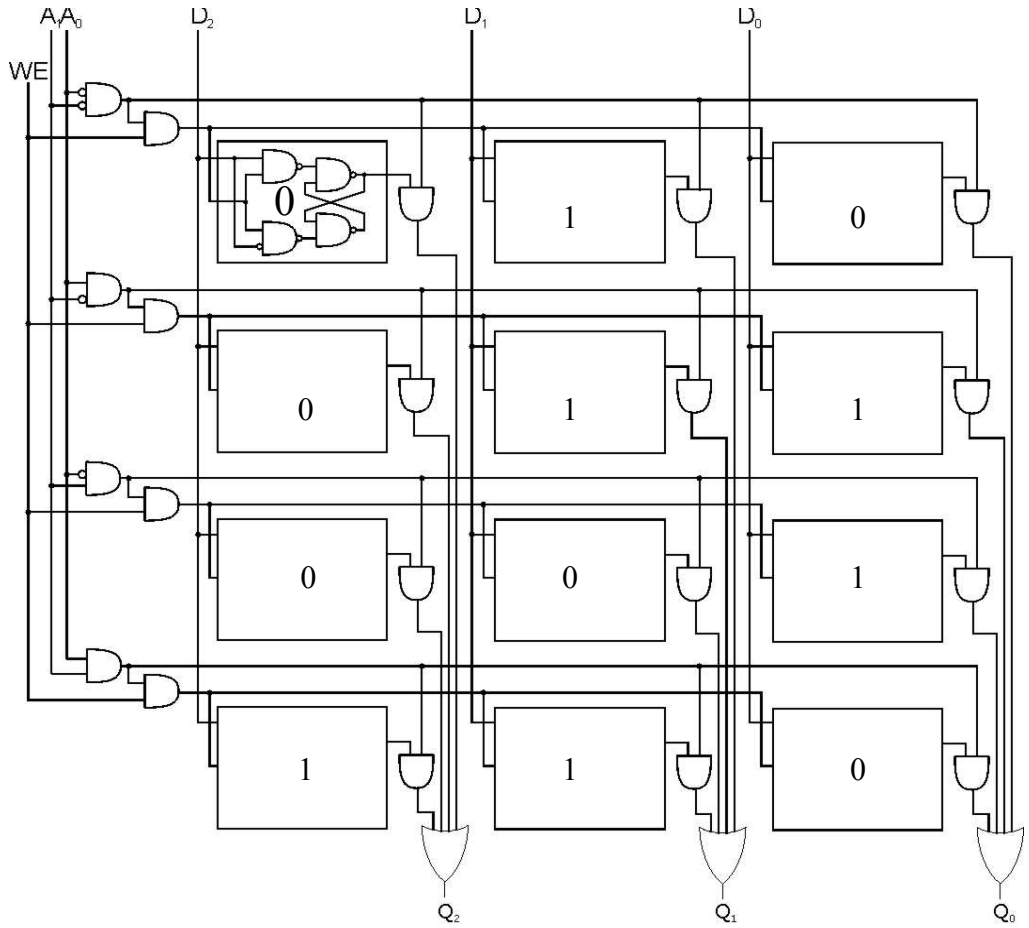
37) For the above circuit, what is the correct way to set M to the value of 1?
a) Set S to 1, R to 0
b) Set S to 0, R to 0
c) Set R to 1, S to 0
d) Set R to 0, S to 0, M to 1
e) None of the above

38) For the above circuit, what is the correct way to set M to the value of 0?
a) Set S to 1, R to 0
b) Set S to 0, R to 0
c) Set R to 1, S to 0
d) Set R to 0, S to 0, M to 1
e) None of the above

39) For the above circuit, what is the correct way to not change the value of M?
a) Set S to 1, R to 0
b) Set S to 0, R to 0
c) Set R to 1, S to 0
d) Set R to 0, S to 0, M to 1
e) None of the above

Part 3: Do you remember me? [3 points each]

Imagine you have 4x3 bit DRAM with the initial contents as shown and commands are sent to DRAM in the order shown below. **After each of the EIGHT (8) commands below are executed in order**, what will be the output of the circuit?



40) Command 1:

WE	A_1	A_0	D_2	D_1	D_0
0	**0**	**0**	**0**	**0**	**0**

Output?

a) Q2 = 0, Q1 = 0, Q0 = 0
b) Q2 = 0, Q1 = 0, Q0 = 1
c) Q2 = 0, Q1 = 1, Q0 = 0
d) Q2 = 0, Q1 = 1, Q0 = 1
e) None of the above

41) Command 2:

WE	A_1	A_0	D_2	D_1	D_0
0	**0**	**1**	**0**	**0**	**0**

a) Q2 = 0, Q1 = 0, Q0 = 0
b) Q2 = 0, Q1 = 0, Q0 = 1
c) Q2 = 0, Q1 = 1, Q0 = 0
d) Q2 = 0, Q1 = 1, Q0 = 1
e) None of the above

42) Command 3:

WE	A_1	A_0	D_2	D_1	D_0
0	**1**	**1**	**0**	**0**	**0**

a) Q2 = 0, Q1 = 0, Q0 = 0
b) Q2 = 0, Q1 = 0, Q0 = 1
c) Q2 = 0, Q1 = 1, Q0 = 0
d) Q2 = 0, Q1 = 1, Q0 = 1
e) None of the above

43) Command 4:

WE	A_1	A_0	D_2	D_1	D_0
1	**0**	**1**	**0**	**0**	**1**

a) Q2 = 0, Q1 = 0, Q0 = 0
b) Q2 = 0, Q1 = 0, Q0 = 1
c) Q2 = 0, Q1 = 1, Q0 = 0
d) Q2 = 0, Q1 = 1, Q0 = 1
e) None of the above

44) Command 5:

WE	A_1	A_0	D_2	D_1	D_0
0	**0**	**1**	**0**	**0**	**0**

a) Q2 = 0, Q1 = 0, Q0 = 0
b) Q2 = 0, Q1 = 0, Q0 = 1
c) Q2 = 0, Q1 = 1, Q0 = 0
d) Q2 = 0, Q1 = 1, Q0 = 1
e) None of the above

45) Command 6:

WE	A_1	A_0	D_2	D_1	D_0
0	**0**	**0**	**0**	**0**	**0**

a) Q2 = 0, Q1 = 0, Q0 = 0
b) Q2 = 0, Q1 = 0, Q0 = 1
c) Q2 = 0, Q1 = 1, Q0 = 0
d) Q2 = 0, Q1 = 1, Q0 = 1
e) None of the above

46) Command 7:

WE	A_1	A_0	D_2	D_1	D_0
1	**1**	**0**	**0**	**1**	**1**

a) Q2 = 0, Q1 = 0, Q0 = 0
b) Q2 = 0, Q1 = 0, Q0 = 1
c) Q2 = 0, Q1 = 1, Q0 = 0
d) Q2 = 0, Q1 = 1, Q0 = 1
e) None of the above

47) Command 8:

WE	A_1	A_0	D_2	D_1	D_0
0	**0**	**1**	**0**	**0**	**0**

a) Q2 = 0, Q1 = 0, Q0 = 0
b) Q2 = 0, Q1 = 0, Q0 = 1
c) Q2 = 0, Q1 = 1, Q0 = 0
d) Q2 = 0, Q1 = 1, Q0 = 1
e) None of the above

Part 4: A Little Something about Everything [2 points each]
For each of the following questions, designate whether the statement is True or False

48) A single bit can be used to encode a single logical value of True or False

49) A set of bits can be used to encode letters and words

50) A set of bits can be used to encode the instructions executed by a processor

51) ASCII is used to digitize sound

52) Run-length encoding is a type of lossy compression

53) A combinational circuit computes a Boolean function of its inputs

54) A combinational circuit can remember values using feedback

55) To add together two N-bit numbers, one needs a chain of (2*N) 1-bit full adders

56) On a modern computer, a cache is usually faster than main memory (RAM)

57) On a modern computer, main memory (RAM) usually has greater capacity (i.e., can hold more data) than the disk

58) The ALU performs mathematical and logical operations for machine instructions

59) Variables of a program can be stored in memory (RAM)

60) Variables of a program can be stored on disk

61) Instructions of a program can be stored in memory (RAM)

62) Output devices move data from memory (RAM) to the processor

63) The Program Counter (PC) determines the next instruction that will be executed

64) An Operating System (OS) is hardware that converts software into a useful form for different applications

65) The OS gives each running process the illusion that it has all of physical memory to itself

66) The OS uses space sharing to divide physical memory between different processes

67) First-come-first-served (FCFS) can be used to schedule processes on the CPU

68) Shortest-job-first (SJF) scheduling could allow some processes to starve

69) TCP may divide a message into multiple packets before sending the packets through the network.

70) Different packets of the same message are routed along the same path of the network between the sender and receiver.

71) TCP reduces the rate at which a client sends packets if it detects that the network is congested.

72) TCP infers that the network is congested when it sees out-of-order packets of a message.

73) If packets are received out of order, the receiver asks the sender to resend the misordered packets of the message.

74) HTTP is used to ensure that eavesdroppers cannot read messages sent between a client machine and a web server.

Part 5: Failure is Impossible [5 points each]

75) You are responsible for building a distributed service that must be able to handle at most TWO (2) machines **crashing** (i.e., the machines will fail "**fail-stop**"). How many machines do you need within your service to keep the service available?

a) 1
b) 3
c) 4
d) 5
e) 7

76) You are responsible for building a distributed service that must handle at most THREE (3) machines crashing **or giving wrong results**. How many machines do you need within your service to keep the service available?

a) 3
b) 4
c) 5
d) 6
e) 7

You are on an island populated by two tribes. Members of one tribe always tell the truth. Members of the other tribe always lie. Tribe members can all recognize one another. For each of the following situations, determine which tribe each person is from. (We recommend creating a truth table to enumerate the possibilities.)

77) You meet two people A and B from the island. A says, "1+1 = 2." B says, "1+1 = 5" What tribe is A from? What tribe is B from?
   a) A truth teller, B truth teller
   b) A truth teller, B liar
   c) A liar, B truth teller
   d) A liar, B liar
   e) Can't identify at least one of the people

78) You meet two people C and D from the island. C says "Exactly one of us is a liar." D says, "1+1=3." What tribe is C from? What tribe is D from?
   a) C truth teller, D truth teller
   b) C truth teller, D liar
   c) C liar, D truth teller
   d) C liar, D liar
   e) Can't identify at least one of the people

79) You meet two people E and F from the island. E says "F is a liar." F says "1+1=2." What tribe is E from? What tribe is F from?
   a) E truth teller, F truth teller
   b) E truth teller, F liar
   c) E liar, F truth teller
   d) E liar, F liar
   e) Can't identify at least one of the people

80) You meet two people G and H from the island. G says "We are both liars."
   a) G truth teller, H truth teller
   b) G truth teller, H liar
   c) G liar, H truth teller
   d) G liar, H liar
   e) Can't identify at least one of the people

This is the END of your CS 202 Final Exam. We hope you have a great Winter Break!