INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Computer Science and Engineering

Switching Circuits and Logic Design (CS21002)

Class Test – I (Spring)

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Date: Wed, Jan 20, 2021 *Marks:* 20 *Time:* 9:10-10:00am (FN)

Answer ALL the questions using xournal or similar software to edit the PDF

Q1: You are to design a two-digit decimal adder, using a binary coded decimal (BCD) representation. In BCD representation, each decimal digit is represented by its corresponding four bit binary representation. Bit combinations representing values of decimal ten or greater are not valid BCD patterns. Thus, a two-digit decimal number is represented by two sets of four bits. For example the decimal number 25 is represented in BCD as `0010 0101`.

A two-digit decimal adder takes two decimal numbers represented as BCD and produces a two-digit BCD sum and a single carry-out bit (9 bits total). For example, The numbers 25 (`0010 0101`) and 75 (`0111 0101`) add to 100, i.e., sum: `0000 0000` and carry-out: `1`.

Your roll number is of the form $nx_1DDnnnnx_0$. Consider the decimal number x_1x_0 = 99.

(a) Write down the steps for adding a pair of two-digit decimal numbers represented as BCD. Explain your steps with the example of adding x_1x_0 and 69. 10

⇒ Convert 99 to BCD ⇒ A: 1001, B: 1001

⇒ Convert 69 to BCD ⇒ C: 0110, D: 1001

⇒ Use Full Adder on B and D. = R

⇒ Use Full Adder on A and C = L

If R ≥ 10, then subtract 10 from it and Add 1 to L.

⇒ If L ≥ 10 then subtract 10 from it and take 1 as a carry

⇒ Example 99 + 69

A B

⇒ 1001 1001 (99)

0110 1001 (69)

C D

B+D = 10010 (18) → R

A+C = 1111 (15) → L

Now, since B+D (R) ≥ 10, we do R = R - 10

Thus, R = 1000 (8)

Now, we add 1 to L, we do L = L + 1

Thus, L = 10000 (16)

Now, since L ≥ 10, we do L = L - 10

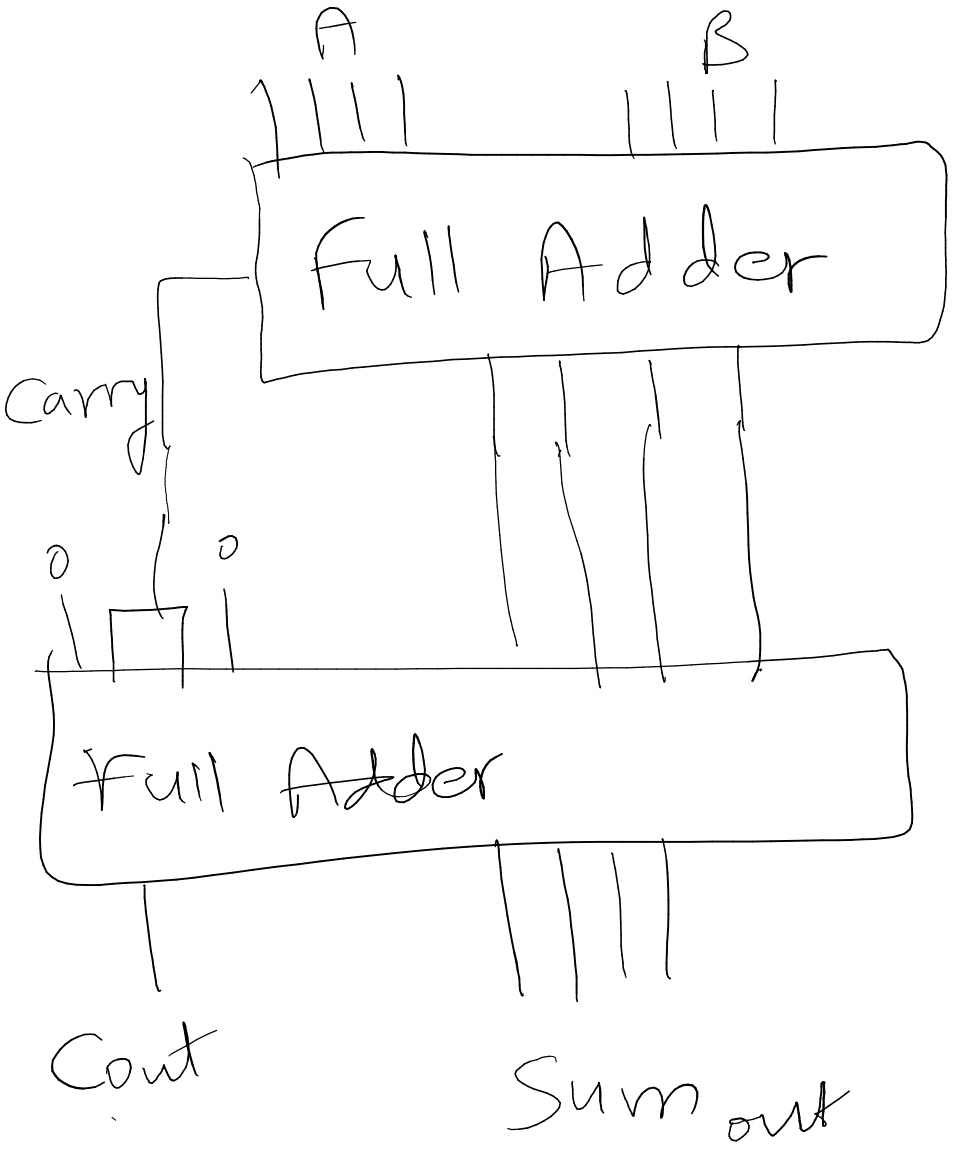
Thus, L = 0110

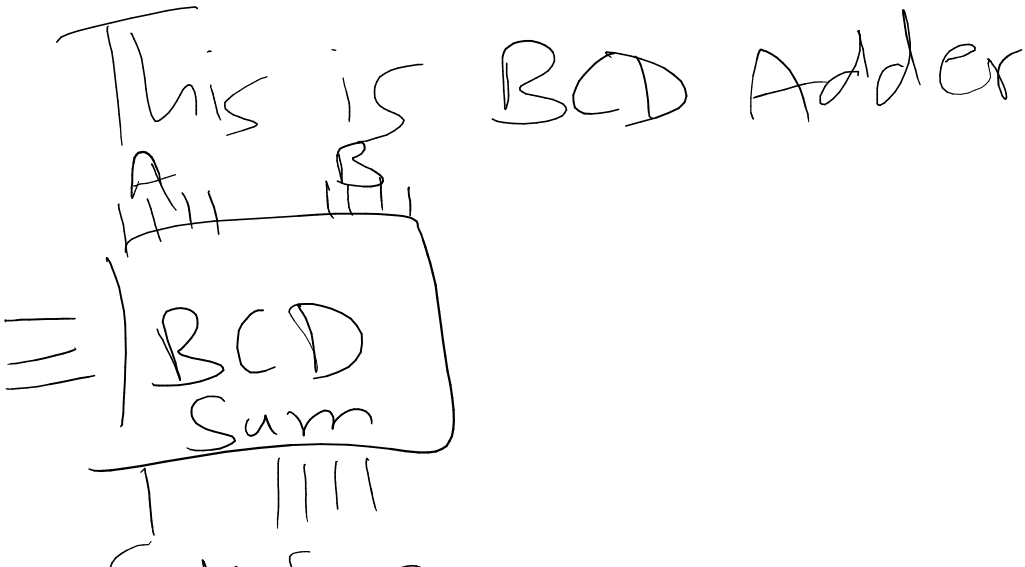
Now, we take 1 as a carry.

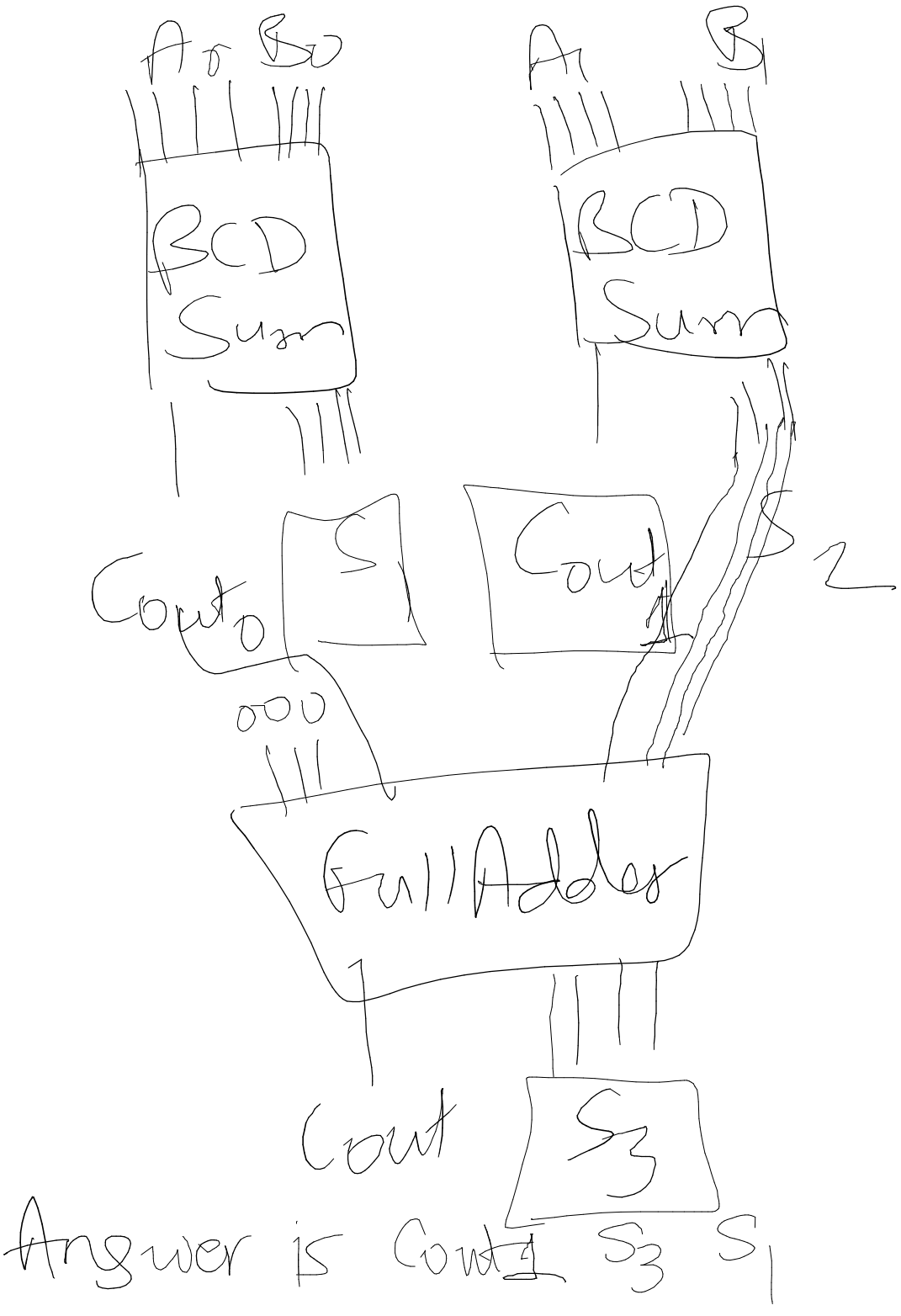
Thus, we have 0001 0110 1000

which is the BCD number for 168

(b) Suppose you have 4-bit binary adders, producing a binary sum and a carry-out. Use these adder blocks, along with logic gates, to design a two-digit BCD adder circuit. 10







Answer is Cout1 S3 S1