Computer Architecture
Jacobs University Bremen
Dr. Heinrich Stamerjohanns

Course: 320241
October 21st, 2011

Midterm

Your name: _____

Problem E.1 *Number systems and Codes* (5 points)

a) Convert the (unsigned) binary number 1010110_2 to its equivalent decimal value.

b) List the octal numbers in sequence from 170_8 to 210_8.

c) What is the minimum decimal number that you can count down to using 10 bits, if the number is represented in two's complement?

d) Please convert $C4A_{16}$ to octal.

e) Please convert the BCD number 1000001101101001_{BCD} to decimal.

Problem E.2 *Two's complement* (3 points)

Maybe the most important binary representation of integer numbers is two's complement. Write the following numbers in two's complement notation using five bits. Comment if necessary.

a) 5

b) −7

c) −16

Problem E.3 *Reverse two's complement* (3 points)

Reverse two's complement problem: given the following two's complement numbers, give their decimal representation (the first bit is the sign bit).

a) 1110

b) 010101

c) 11010

Problem E.4 *Number systems and Codes* (3 points)

Please write the results when each of these numbers incremented by one.

a) 7779_{16}

b) 9999_{16}

c) $0FFF_{16}$

d) $9FF_{16}$

e) $100A_{16}$

f) 0101_8

Problem E.5 *Data Transmission* (4 points)

A counter in a copy store that counts between 000 and 999 transmits its count to the cashier using BCD code. An odd-parity bit is also included at the end of each transmission (it appears as the most left bit below). Examine each of the code groups below, and assume that each one has just been transferred from the copy machine to the cashier. Some of the groups contain errors. Assume that *no more than* two errors have occured for each group. Determine which of the code groups have a single error and which of them definitely have a double error. Keep in mind that this is BCD code.

a) 0100011101100

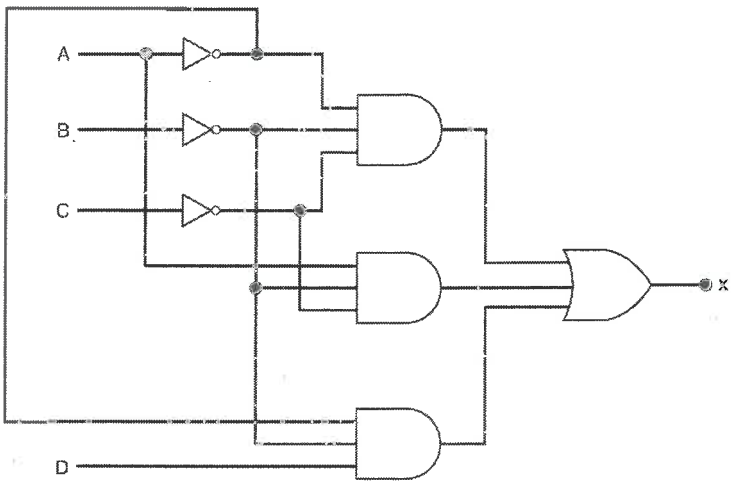
b) 1001010110000

c) 0111110000011

d) 1000011000101

Problem E.6 *Please compute* $77 + 47$ *in BCD* (1 point)

Problem E.7 *A logic circuit* (4 points)



Determine the output expression for the circuit of the figure above and simplify it.

Problem E.8 *A logic cicuit* (2 + 3 = 5 points)

Please draw the corresponding logic circuit $x = (\overline{(M + N} + \overline{P}Q)$ and then algebraically simplify the expression.

Problem E.9 *Rewriting I* (2 points)

$X + \overline{X}Y$ can be rewritten as?

Do not worry if you do not know directly, this can easily be deduced..., actually, a plain answer is not fully sufficient, please prove...

Problem E.10 *Rewriting II* (2 points)

$\overline{X} + XY$ can be rewritten as?

Do not worry if you do not know directly, this can easily be deduced..., actually, a plain answer is not fully sufficient, please prove...

Problem E.11 *Karnaugh map* (5 points)

Consider the following truth table. Please determine the sum-of-products expression and then using a Karnaugh map, simplify the resulting expression. Please *shortly* describe your steps, so that one can follow what you have been doing.

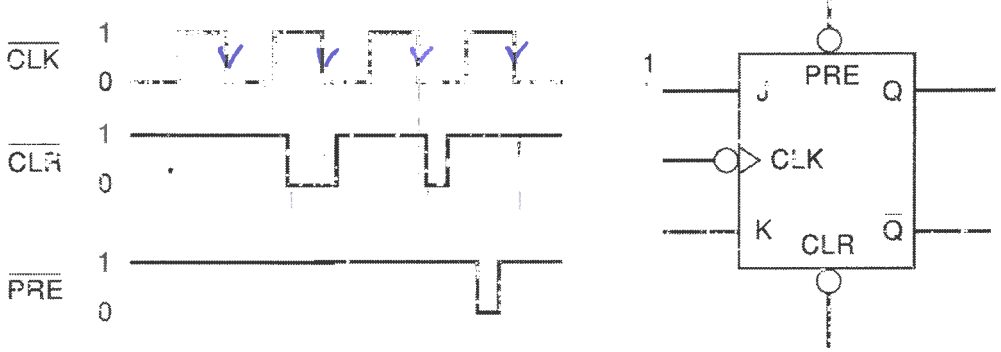
A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

Problem E.12 *J-K Flip-Flop* (5 points)

In principal an J-K Flip Flop consists of an edge detector, a pulse-steering circuit and a NAND latch. Please draw the internal circuitry of an NGT edge triggered J-K-Flip Flop and determine its truth table.

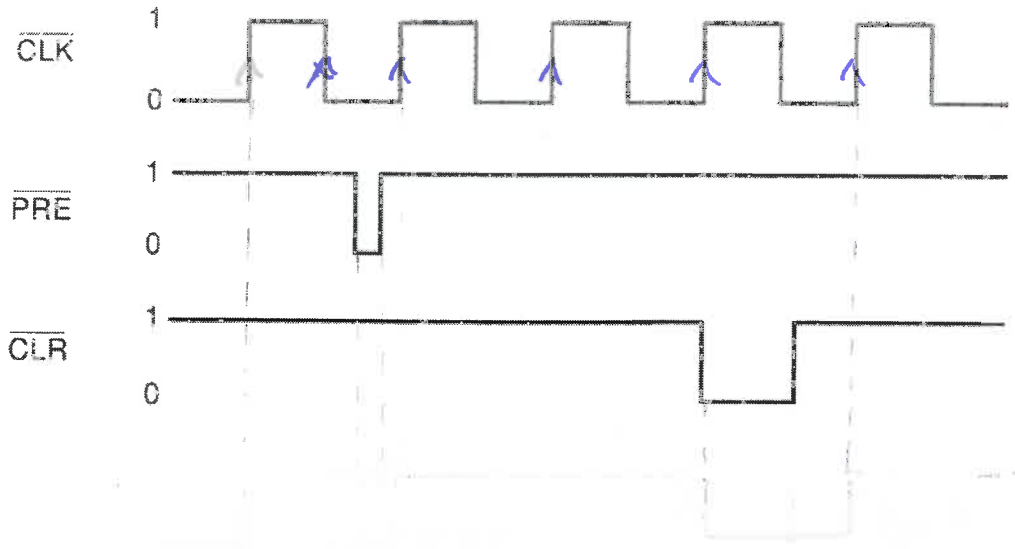
Problem E.13 *J-K Flip-Flop* (4 points)

Determine the Q waveform for the Flip-Flop in the figure below. Assume that $Q = 0$ initially, and remember that $\overline{CLR}$ and $\overline{PRE}$ are asynchronous inputs.



Problem E.14 *J-K Flip-Flop* (4 points)

Please apply the $\overline{CLK}$, $\overline{PRE}$, and $\overline{CLR}$ waveforms of the figure below to a positive-edge-triggered D flip-flop with active-LOW asynchronous inputs. Assume the D is kept HIGH and Q is initially LOW. Determine the Q-waveform.



Points: 50
Bonus: 0