Nimi/Name:_____ **Op.nro/Student number:**_____

Email: _____ **Huom! Voit vastata myös Suomeksi tähän tenttiin.**

1) Check the correct bullet. Each correct answer gives +½ points, each wrong –½ points after four wrong ones. Empty bullets –½ points. (Max 12 points).

The largest digit value in a redundant number system is at maximum r-1	O true	O false
Number system defines how the digits look like in the digit vector.	O true	O false
The conversion from one radix to another of the fractional part of a number always converges.	O true	O false
One possible sign extended version of a negative 9's complement number 923 (r=10) is 9923.99.	O true	O false
Negative numbers can always be represented with the help of complementation constant C in all number systems.	O true	O false
The terms MSB (Most Significant Bit) and LSB (Least Significant Bit) can only be used in a weighted number system.	O true	O false
The largest digit value in a non-canonical number system is at maximum r+1	O true	O false
10's complement number 877 is same as -124 in normal decimal repreresentation.	O true	O false
ULP means the weight of the least significant digit.	O true	O false
The complementation constant for an seven-complement number is 64, if n=2 and r=8.	O true	O false
Lookbehind borrow is used in the direct subtraction of unsigned numbers without complementing either operand.	O true	O false
It is possible to change a half-adder to a half-subtractor by only adding one inverter in an AND-gate input that forms the carry-out signal.	O true	O false
Carry-free additions can be performed with SD-number system and radix r < 2.	O true	O false
The operation time of Carry-complete adder is independent of the operands.	O true	O false
Parallel-prefix adders save sum and carry bits separately.	O true	O false
Radix-4 lookbehind recoding produces correct results for 2-complement numbers without any specific correction steps.	O true	O false
2-bit lookbehind and 1-bit lookahead recoding yield the same maximum multiples of the multiplicand that should be added or subtracted from the partial product.	O true	O false
Multiplier recoding makes the operation time independent of the operands.	O true	O false
Braun multiplier is not suitable for 1's complement operands	O true	O false
Normalization ensures preserving as many significant digits as possible in division.	O true	O false
SRT-division results in SD quotient that must be converted to a conventional number.	O true	O false
Normalizing a floating point number means that only fractional numbers not larger than one must be used as the floating point numbers.	O true	O false
The same number range can be obtained in a 256-bit fixed-point number and an 8-bit floating-point number (r=2, mantissa 1 bits minimum).	O true	O false
With the same number of bits there are the same number of representable fixed and floating point numers.	O true	O false

2) Perform addition $X+Y$ using "conditional-sum"-principle into the following Table. Assume $C_{in}=0$ for x_1+y_1. Show with arrows or by other means how do you obtain the sum and carry bits for the next step. (6p).

		i	7	6	5	4	3	2	1	0
	X	x_i	1	0	1	1	0	1	1	0
	Y	y_i	0	0	1	0	1	1	0	1
Step 1	$C_{in}=0$	s								
		c								
	$C_{in}=1$	s								
		c								
Step 2	$C_{in}=0$	s								
		c								
	$C_{in}=1$	s								
		c								
Step 3	$C_{in}=0$	s								
		c								
	$C_{in}=1$	s								
		c								
Sum										

3) Show block diagram of a 5 operand (five numbers are added at the same time), 8 bit carry save adder. Show bit widths of all blocks and components and signal lines between them. Explain the operation. (6 points)

4) Suppose 2's complement numbers. Let multiplicand be 01011_2 and multiplier be 10110_2.
   a) Multiply the numbers (use partial product right shift method). (4 points)
   b) Recode the multiplier with radix-2 Booth recoding method (1-bit scan, lookbehind recoding). (2 points)
   c) Multiply the numbers with above recoding. (4 points)

5) Let there be floating-point numbers $A=0.100000101100\text{x}2^{0111}$ and $B=0.110000010110\text{x}2^{0001}$, for which mantissa (12 bits) is an unsigned fraction $0.5_{10} \le m < 1_{10}$. Calculate A-B with the help of following Table. Round the result using round-to-nearest-even method. Show all steps and explain the names and meaning of potential extra bits. For intermediate steps use max 15 bits for the operands. (8p)

A	B	borrow-in	A-B	borrow-out
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1