CSE2306/1308 Digital Logic

Assignment 1

Due date: Monday, 27th March

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Write your answers in the space provided in the assignment sheets.
Attach additional page if there is not enough space.
Plagiarised assignments will be given a zero mark.

Question 1: Add

$$(21201)_3 + (1221)_3 = \boxed{}$$

Show your working here:

[4 marks]

Question 2: Convert using the **division by the target radix** method:

1. $(347)_{10}$ to radix 3
2. $(753)_{10}$ to radix 4
3. and radix 2

Show your working here:

[2+2+2 marks]

Question 3: Convert using the **multiplication by the source radix** method:

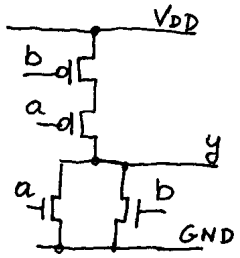
1. $(221121)_3$ to radix 10
2. $(1753)_{10}$ to radix 2
3. and radix 4

Show your working here:

[2+2+2 marks]

Question 4: Consider the following CMOS implementation of a logic gate:

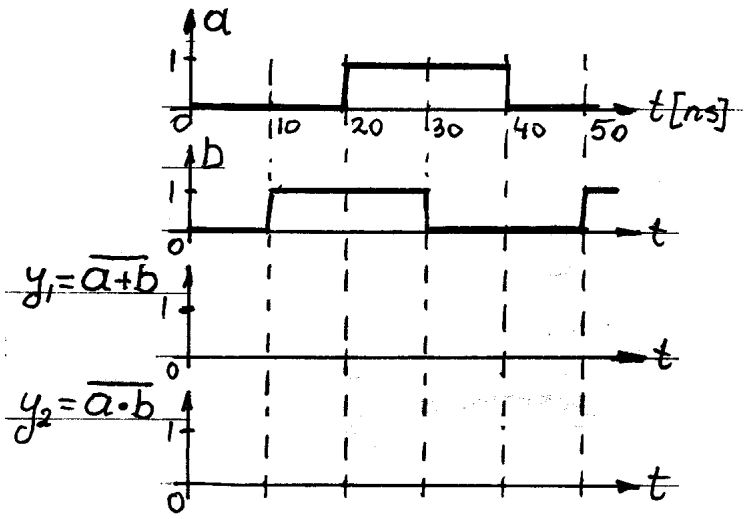
1. Create the truth table $y(a, b)$ for the gate



2. What is the name of the gate?

[2+1 marks]

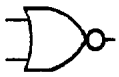
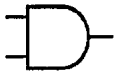
Question 5: Complete the following time waveforms:



What is the frequency of signals **a** and **b** ?

[2+2+1 marks]

Question 6: Complete the following table in the format indicated

Variables A B	Various basic logic functions f1	f2	f3	f4	f5	f6	f7	f8
0 0			0			1		1
0 1			1			0		1
1 0			1			1		1
1 1			0			0		0
Gate name		NAND					XNOR	
Gate Symbol								
Expression	=	=	=	=	= A+B	=	=	=

[8 marks]

Question 7: Complete the body or heading of each truth table column.

Inputs A B C	$\bar{B}\bar{C}$	$\bar{A}+C$	$A(B+\bar{C})$		$\bar{A}C+B\bar{C}$	
0 0 0				0		0
0 0 1				1		1
0 1 0				0		0
0 1 1				0		1
1 0 0				0		1
1 0 1				1		1
1 1 0				0		1
1 1 1				0		1

[6 marks]

Question 8: Give the formula for the maximum number of different logic functions (truth tables) that can be constructed using **exactly** n binary variables

[2 marks]

Question 9: The partly completed equations below refer to either a minterm or a Maxterm. Complete each equation to show the equivalence between the longhand and the shorthand forms.

$A \bullet B \bullet \bar{C} =$	$\bar{A}+B+C =$	$= M_3$	$= m_5$
$\bullet \quad \bullet \quad = \quad _2$	$= M_6$	$\bar{A} \bullet B \bullet C =$	$+ \quad + \quad = \quad _7$

[8 marks]

Question 10: Logic functions P, Q, R, S, T and U have these truth tables:

Inputs A B C	P	Q	R	S	T	U
0 0 0	1	0	0	1	1	1
0 0 1	0	1	0	1	0	1
0 1 0	1	1	1	0	1	0
0 1 1	1	0	0	0	0	0
1 0 0	1	0	0	1	1	0
1 0 1	0	1	1	0	1	1
1 1 0	1	0	0	1	0	0
1 1 1	0	1	1	0	0	1

Complete each expression below to become a standard canonical form of the logic function. Use either the index list, or the shorthand format, as indicated by the partly complete answer:

$P = \prod M($ $\qquad$ $Q = \overline{\sum m(}$

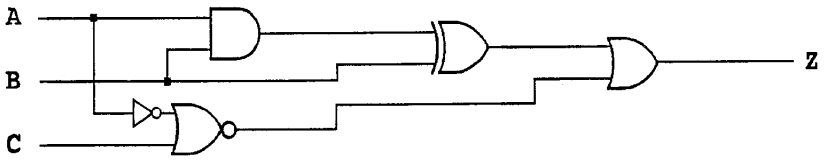
$R = \sum m($ $\qquad$ $S = m$

$T = M$ $\qquad$ $U = \overline{M}$

[6 marks]

Question 11:

1. Give a Boolean expression that corresponds to this logic circuit:



2. Develop a truth table for the circuit, showing columns for at least the output of each 2-input gate. You should invent new variable names for these intermediate outputs.

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

[2+8 marks]

Question 12: Using logic variables A, B, C give these Boolean algebra laws:

a) Distributive laws: #1 #2

b) De Morgan's laws: #1 #2

c) Four useful laws whose result is a logic constant.

Use suitable Boolean algebra law to:

d) $F = A(B+\bar{C}) + \overline{(\bar{B}+C)}$ **Expand** "F" into a sum of minterms.

e) $G = \bar{A}\bar{B}\bar{C} + C\overline{(A\bar{B})} + \bar{A}(C+AB)$ **Simplify** "G" as far as possible.

[2+2+2+3+3 marks]

Question 13: Consider the following four-variable function

$$y(x_3, x_2, x_1, x_0) = \sum(0, 2, 3, 6, 7, 9, 11, 15)$$

Use the Karnaugh map to derive the following minimal forms of the function y:

1. SoP
2. PoS
3. Inverted SoP
4. Inverted PoS
5. NAND form
6. NOR form

[12 marks]

Question 14: Consider the following four-variable function

$$y(x_3, x_2, x_1, x_0) = \sum(0, 1, 4, 5, 6, 8, 9, 11, 15)$$

1. Implement the above function using a decoder generating Maxterms. Draw a suitable diagram

2. Implement the above function using the 8-to-1 multiplexer. Give the modified truth table and the relevant diagram.

[4+4 marks]

[Total marks: 100]