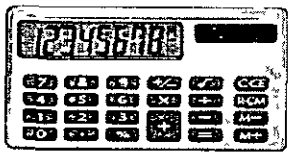
UNIVERSITY EXAMINATIONS



UNIVERSITEITSEKSAMENS

UNISA university of south africa

DIG1501

October/November 2014

DIGITAL SYSTEMS I (THEORY)

Duration 3 Hours

100 Marks

EXAMINERS
FIRST *MR PO UMENNE*
SECOND MR NR NETSHIKWETA

Programmable pocket calculator is permissible

Closed book examination

This examination question paper remains the property of the University of South Africa and may not be removed from the examination venue

This examination question paper consists of 7 pages

Answer all the questions

PLEASE NOTE: **IF YOU HAVE THE OPINION THAT INSUFFICIENT INFORMATION IS SUPPLIED FOR YOU TO ANSWER A PARTICULAR QUESTION, MAKE A REALISTIC ASSUMPTION, MOTIVATE IT AND THEN ANSWER THE QUESTION.**

NUMBER SYSTEMS OPERATIONS AND CODES

QUESTION 1

1 1 Express the decimal number -99 as an 8-bit number in the 2's complement form (3)

1 2 Determine the decimal value of the following signed binary number in the 2's complement form 10111111 (3)

1 3 Convert the hexadecimal number $8A9D_{16}$ to decimal (3)

1 4 Convert the following BCD number to decimal 100001110000 (3)

1 5 Divide 01110100 by 00010001 (3)

1 6 Convert the Gray code to Binary code, 11000010001 (3)

[18]

LOGIC GATES

QUESTION 2

2 1 Determine the gate output for the input waveforms in figure 1 below and draw the timing diagrams

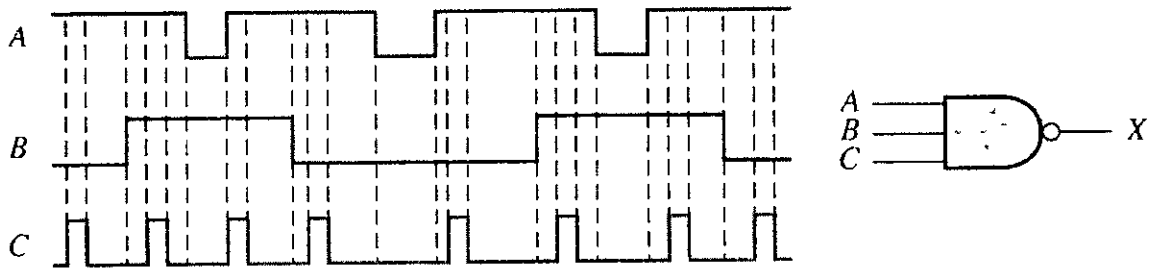


Figure 1

(5)

2 2 A seat belt alarm system works such that when the ignition switch is turned on and the seat belt is unbuckled, the alarm comes on and the car will not move Assume a LOW is required to activate alarm

Design a truth table, an equation and a circuit diagram (10)

[15]

BOOLEAN ALGEBRA AND LOGIC SIMPLIFICATION

QUESTION 3

3 1 Apply DeMorgan's theorems to the expression

$$\overline{(A + \bar{B} + C + \bar{D})} + \overline{ABC\bar{D}}$$ (2)

3 2 Using Boolean algebra, simplify the following expressions

$$AB + (\bar{A} + \bar{B})C + AB$$ (4)

3 3 Convert the following expression to a standard sum-of-products form

$$(A + \bar{B}C)C$$ (4)

3 4 Using Boolean algebra technique simplify the following expression as much as possible

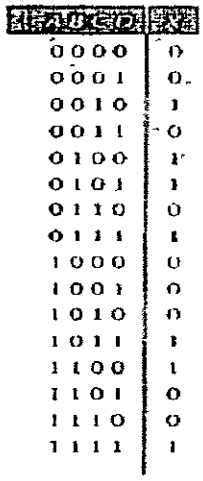
$$A(A + AB)$$ (3)

[13]

KARNAUGH MAP

QUESTION 4

4 1 For the truth table shown in Figure 2,



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

Figure 2

4 1 1 Derive a standard SOP Expression from it (3)

4 1 2 Minimise the expression using a K-map (6)

4 2 Use the Karnaugh map method to implement the minimum SOP expression for the logic function specified in the truth table in figure 3 (7)

INPUTS A	B	C	D	OUTPUT X
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

Figure 3

[16]

COMBINATIONAL LOGIC ANALYSIS

QUESTION 5

For the input waveforms shown in Figure 4,

5 1 Write out the Boolean expression for the output waveform (2)

5 2 Sketch the logic circuit that will generate the output waveform (3)

5 3 Express the Boolean expression in 5 1 using only NAND gates (3)

5 4 Sketch the resulting logic circuit of the Boolean expression using **ONLY** NAND gates (4)

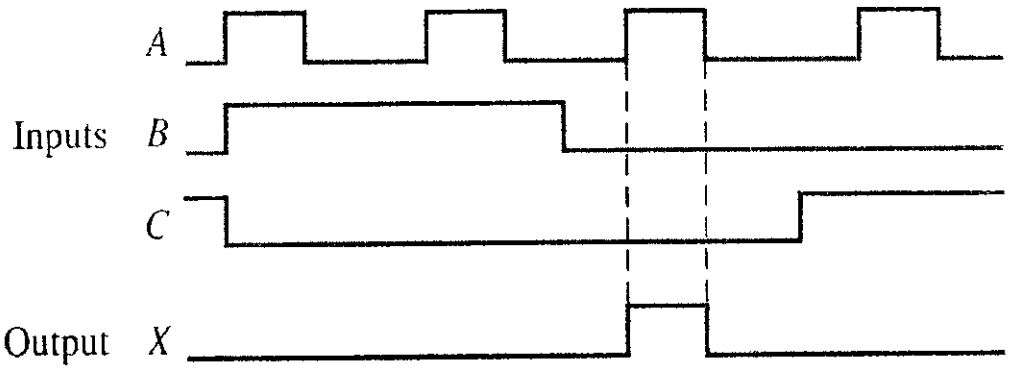


Figure 4

[12]

FUNCTIONS OF COMBINATIONAL LOGIC

QUESTION 6

6 1 For the multiplexer shown in figure 5, the data input states are as follows,

$$D_0 = 0, D_1 = 1, D_2 = 1, D_3 = 0$$

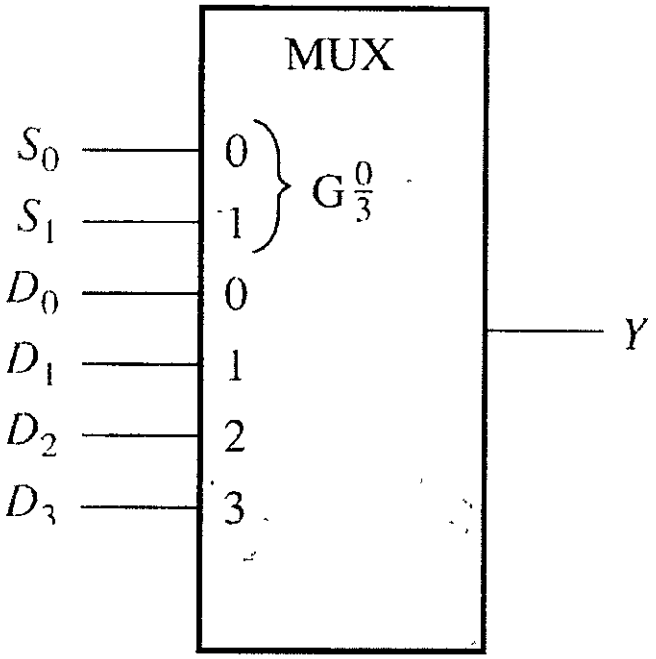


Figure 5

6 1 1 If the data-select inputs to the multiplexer in figure 5 are sequenced by the waveforms shown in figure 6, determine the output waveform, do a truth table (7)

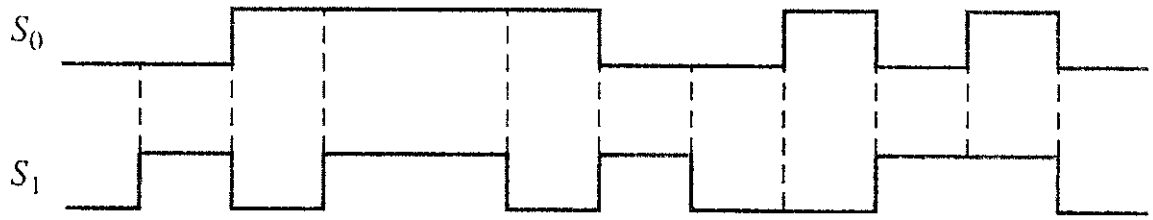


Figure 6

6 1 2 Sketch the output waveform (3)

6 2 For the following codes write out and sketch the decoding logic if an active-HIGH (1) output is required,

6 2 1 11100 (4)

6 2 2 101010 (5)

6 3 For the parallel adder in figure 7, determine the complete sum by analysis of the logical operation of the circuit Verify your result by longhand addition of the two input numbers (7)

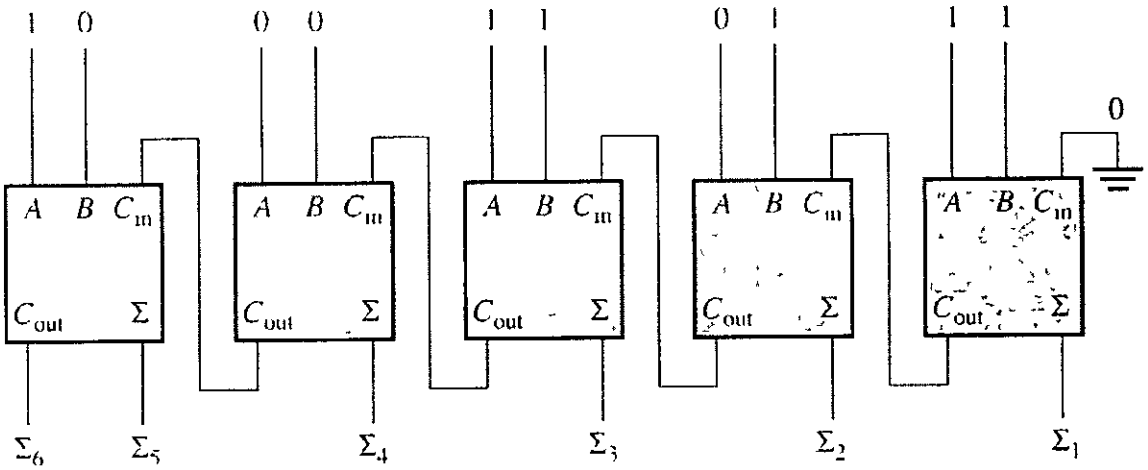


Figure 7

[26]

TOTAL: [100]

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