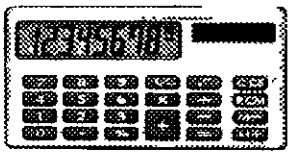
UNIVERSITY EXAMINATIONS



UNIVERSITEITSEKSAMENS

UNISA university of south africa

DIG1501

October/November 2013

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 3 pages

Answer all the questions

Open Rubric

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.

QUESTION 1 *Introductory Concept*

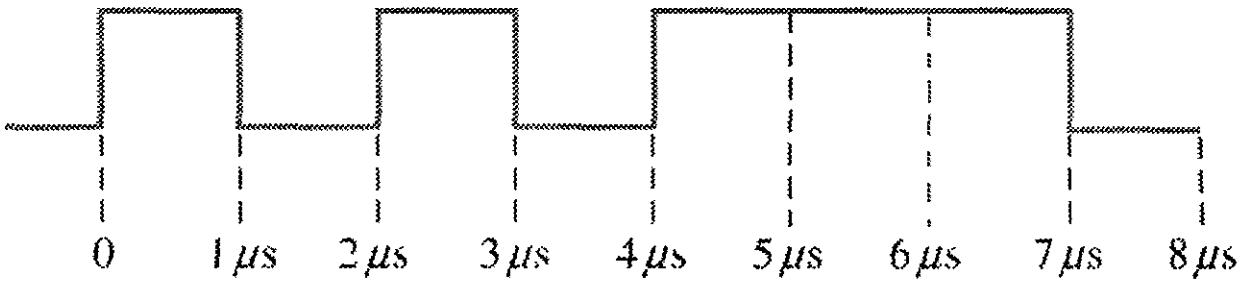


Figure 1

1 1 What is the total serial transfer time for the eight bits in figure 1? (3)

1 2 *What is the total parallel transfer time?* (3)

[6]

QUESTION 2 Number Systems, Operation and Codes

2 1 Convert the decimal fraction to binary using repeated multiplication by 2 (3)

0 9028

2 2 Determine the 1's complement of the following binary number (3)

11010111

2 3 Divide 01000100 by 00011001 (3)

2 4 Convert the hexadecimal number $8D_{16}$ to decimal (3)

2 5 Convert the Gray code to binary 11000010001 (3)

[15]

QUESTION 3 Logic Gates

3 1 Determine the gate output for the input waveforms in figure 2 below (6)

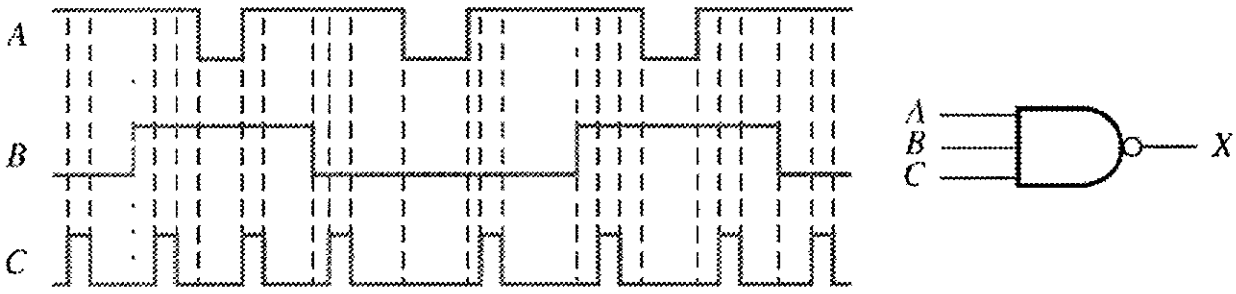


Figure 2

3 2 Sensors are used to monitor the pressure and the temperature of a chemical solution stored in a vat The circuitry for each sensor produces a HIGH voltage when a specified maximum value is exceeded An alarm requiring a LOW voltage input must be activated when either the pressure or the temperature is excessive Design a circuit for this application (14)

[20]

QUESTION 4 Boolean Algebra and Logic Simplification

4 1 Apply DeMorgan's theorem to the following expression (4)

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

4 2 Using Boolean algebra, simplify the following expression (4)

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

4 3 Convert the following expression to standard sum-of-products (SOP) form (4)

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

4 4 Use the karnaugh map method to implement the minimum SOP expression for the logic function specified in figure 3 below (10)

INPUTS				OUTPUT
A	B	C	D	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

[22]

QUESTION 5 Combinational Logic Analyses

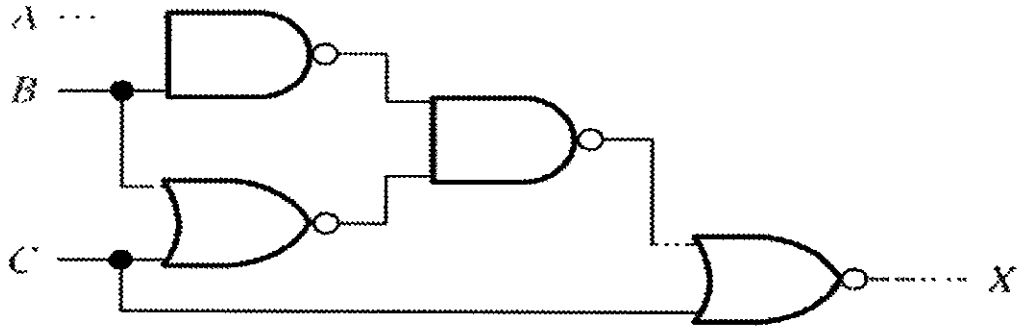


Figure 4

Implement the logic circuit in figure 4 using only NAND gates (20)

[20]

QUESTION 6 **Functions of Combinational Logic**

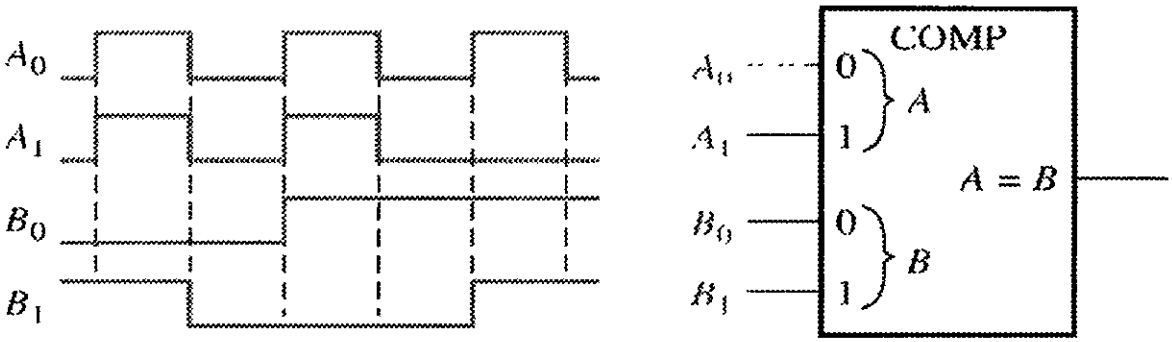


Figure 5

6 1 The waveforms in figure 5 are applied to the comparator as shown Determine the output (A=B) waveform (7)

6 2 For the multiplexer in figure 6 below, the following input states are present, $D_0 = 0, D_1 = 1, D_2 = 1, D_3 = 0$ If the data select inputs (S_1, S_0) to the multiplexer are sequenced as shown by the waveforms in figure 7 below, determine the output waveform with the input states (10)

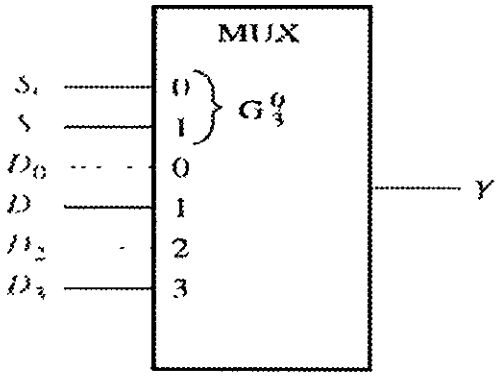


Figure 6

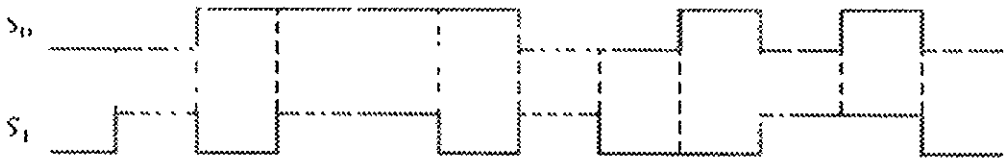


Figure 7

[17]

Total: 10

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APPENDIX A

DIGITAL SYSTEMS 1
FORMULAE SHEET

Basic Laws

$X \bullet 0 = 0$ $\quad$ $X + 1 = 1$ $\quad$ $X \bullet \overline{X} = 0$

$X + 0 = X$ $\quad$ $X \bullet X = X$ $\quad$ $X + \overline{X} = 1$

$X \bullet 1 = X$ $\quad$ $X + X = X$ $\quad$ $\overline{\overline{X}} = X$

Commutative Laws

$X \bullet Y = Y \bullet X$ $\quad$ $X + Y = Y + X$

Associative Laws

$(X + Y) + Z = X + (Y + Z) = X + Y + Z$

$(X \bullet Y) \bullet Z = X \bullet (Y \bullet Z) = X \bullet Y \bullet Z$

Distributive Laws

$X \bullet (Y + Z) = (X \bullet Y) + (X \bullet Z)$

$X + (Y \bullet Z) = (X + Y) \bullet (X + Z)$

De Morgan's Theorem

$\overline{X \bullet Y} = \overline{X} + \overline{Y}$ $\quad$ $\overline{X + Y} = \overline{X} \bullet \overline{Y}$

Logic Theorems

$X + X \bullet Y = X$ (Absorption)

$X + \overline{X} \bullet Y = X + Y$

$X \bullet Y + X \bullet \overline{Y} = X$ (logic adjacency)

$X \bullet Z + \overline{X} \bullet Y \bullet Z = X \bullet Z + Y \bullet Z$

$X \bullet Y + X \bullet Z + \overline{Y} \bullet Z = X \bullet Y + \overline{Y} \bullet Z$