ZCAS University

ALL FIRST YEAR PROGRAMMES - SOCTAS

CCS1412 – FUNDAMENTALS OF DIGITAL LOGIC DESIGN

MID SEMESTER EXAMINATION

25TH OCTOBER 2023

12:30 HRS-15:30HRS

TIME ALLOWED: WRITING – THREE HOURS

READING – 5 MINUTES

INSTRUCTIONS:

1. Section A: this question is **compulsory** and must be attempted.
2. Sections B: Answer **THREE (3)** questions from this section.
3. This examination paper carries a total of **100 marks**.
4. **NO** calculators allowed.
5. Candidates must **not turn this page** until the invigilator tells them to do so.

SECTION A: Question 1 is compulsory and must be attempted.

Question 1

(a) Truth tables are an indispensable tool in the design and analysis of digital systems. They facilitate the specification, design, verification, testing, and optimization of digital circuits and systems, ensuring that they meet their intended functionality and performance requirements. Consider the truth table of a particular system shown below and answer the questions that follow.

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

i. Obtain the minterm list and write down the canonical Boolean expression for this given system. **[5 Marks]**

ii. Use Boolean algebra to simplify the expression. **[5 Marks]**

iii. Draw the Karnaugh map of the system and use it to obtain the minimised Boolean expression. **[5 Marks]**

iv. Explain what is meant by the term "don't care" entries in a K-map and give TWO instances where these could occur. **[5 Marks]**

(b) Logic gates are the basic building blocks of all flip-flops and other memory elements. Their importance in digital design cannot be overemphasised. There are 3 basic logic gates namely NOT, AND, and OR gates.

a) Draw the circuit of a XOR gate using basic logic gates. **[5 Marks]**

b) Compute the truth table for the XOR gate. **[5 Marks]**

c) From the truth table in (b), derive the corresponding k-map and equation. **[5 Marks]**

d) Minimise the following Boolean function and draw the corresponding logic circuit.

$$f(w,x,y,z) = (w \cdot \bar{x} \cdot (y + x \cdot z) + \bar{w} \cdot \bar{x}) \cdot y$$ **[5 Marks]**

(40 Marks)

SECTION B: Attempt any THREE questions in this section.

Question 2

Given that an arbitrary system is represented by the equation $Q(A,B,C) = \sum m(0,1,4) + \sum d(5,6)$, answer the questions that follow and show all your work.

(a) Deduce the truth table of this system. **[5 Marks]**

(b) From the truth table in (a), derive the corresponding K-map. **[5 marks]**

(c) From the K-map in (b), deduce the optimised Boolean equation. **[5 Marks]**

(d) From the Boolean equation in (c), draw the digital logic circuit using basic gates. **[5 Marks]**

(20 Marks)

Question 3

Answer the following questions justifying your answer **[2 Marks each]**. ***NOTE: YOU GET HALF MARK FOR CORRECT ANSWER WITHOUT JUSTIFICATION, YOU GET NEGATIVE (-1) FOR WRONG ANSWER AND ZERO (0) FOR "I don't Know":***

i. Which of the following is not a universal gate?

A. AND B. NAND C. NOR D. I don't Know.

ii. Which of the following is not a basic building block of a latch?

A. XOR B. NAND C. NOR D. I don't Know.

iii. Which of the following number systems can be represented by 4 bits?

A. Binary B. Octal C. Hexadecimal D. I don't Know.

iv. What are the terms in SOP and POS called?

A. Minterms B. Maxterms C. Both A) and B) D. I don't know.

v. Which of the following digital element is used as the basic building block of a register?

A. Flip-flop B. NOR C. NAND D. I don't Know.

vi. Which of the following sequential elements has a forbidden input combination?

A. SR B. JK C. T D. D E. I don't Know.

vii. The number 255 when converted to decimal is _____?

A. 10101101 B. 11111111 C. 100000000 D. 1111111

E. I don't Know.

viii. When implementing binary adders, what is the sum of 1 + 1 = ?.

A. 0 B. 1 C. 10. D. 10 E. I don't Know.

ix. Which of the following circuits are used to store data?

A. Sequential B. Combinational C. Logic gates D. I don't Know.

x. Which of the following circuits are used to process data?

A. Sequential B. Combinational C. Logic gates D. I don't Know.

(20 marks)

Question 4

Given that an arbitrary system is represented by the equation Q(A,B,C) = $\sum m(2,3,4,5) + \sum d(6,7)$, answer the questions that follow and show all your work.

(e) Deduce the truth table of this system. **[5 Marks]**

(f) From the truth table in (a), derive the corresponding K-map. **[5 marks]**

(g) From the K-map in (b), deduce the optimised Boolean equation. **[5 Marks]**

(h) From the Boolean equation in (c), draw the digital logic circuit using basic gates. **[5 Marks]**

(20 Marks)

Question 5

Determine whether the following is True or False and justify your answer **[2 Marks each]:**

a) If you connect two NAND gates in series, you get a NOT gate.

b) Logic gates are made up of semi-conductors.

c) Computers use only the binary system to represent data.

d) When you AND a variable with its complement, the result is always a 1.

e) When you OR a variable to its complement, the result is always a 1.

f) When you connect the two inputs of a JK flip-flop, the resultant flip-flop is a T flip flop.

g) Latches are edge triggered whilst flip-flops are level triggered.

h) Adding the numbers 4 and 5 in binary results in an overflow.

i) The CPU can read data from both the RAM and Hard Disk.

j) Amongst the memory elements RAM, Registers, Cache, HDD, and USB, Cache is the fastest.

(20 marks)

----------END-OF-EXAM----------