UNIVERSITY OF ESWATINI

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIGITAL SYSTEMS

COURSE CODE – EEE323

MAIN EXAMINATION

DECEMBER 2019

DURATION OF THE EXAMINATION - 3 HOURS

INSTRUCTIONS TO STUDENTS

1. There are **FIVE** questions in this paper. Answer any **FOUR** questions.
2. Each question caries 25 marks.
3. Show all your steps clearly in any calculations/work.
4. Start each new question on a fresh page.
5. Make sure that this exam contains 3 pages including this one.

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QUESTION ONE (*25 marks*)

(a) (9 pts) Complete the following table of equivalent values.

Decimal	Binary	Octal	Hexadecimal
			A9.C2
	10101.01101		
41.125			

(b) (5 pts) Simplify $f(x, y, z) = \prod(1,4,5,6)$ to a product of 2 sums.

(c) (6 pts) Using Boolean algebra, simplify the following Boolean expression to a minimum number of literals. Show all your steps!

(i) $(x'y' + z)' + z + xy + wz$

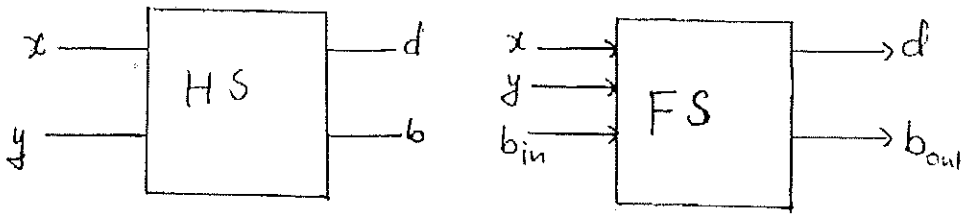
(ii) $A'B(D' + C'D) + B(A + A'CD)$

(d) (5 pts) Implement the following Boolean function with NAND gates:

$F = y' + yz + w'z'$

QUESTION TWO (*25 marks*)

a) (4+6+5 pts) The graphical symbols of a half-subtractor (HS) and a full-subtractor (FS) for computing b, d = x - y, where b stands for borrow and d stands for difference are shown below:



(i) Derive the truth table and minimal cost Sum of Product (SOP) implementation for the HS.

(ii) Derive the truth table and a minimal cost SOP implementation for the FS.

(iii) Show how to build a FS from two HS blocks and an additional gate.

(b) (10 pts) Simplify the following using a k-map:

(i) F = C'D + ABC' + ABD' + A'B'D

(ii) F(A, B, C, D) = Σ(0,6,8, 12, 14)
d(A, B, C, D) = Σ(2, 10)

QUESTION THREE (*25 marks*)

(a) (10 pts) Implement the following Boolean function with a multiplexer:

$F(A, B, C, D) = \pi(2,5,6,7,10,11,13,15)$

(b) (15 pts) Design an up-down binary counter that counts from 0 – 6 using T flip-flops. Show your state diagram, state table, and K-maps.

QUESTION FOUR (*25 marks*)

a) (10 pts) A combinational circuit is defined by the following three Boolean functions:

$$F_1(x, y, z) = x'y'z' + xz$$
$$F_2(x, y, z) = xy'z' + x'y$$
$$F_3(x, y, z) = x'y'z + xy$$

Design the circuit with a decoder and external gates.

b) (15 pts) A sequential circuit has two JK flip-flops A and B. two inputs x and y, and one output z. The flip-flop input equations and circuit output equation are:

$$J_A = Bx + B'y' \qquad K_A = B'xy'$$
$$J_B = A'x + x'A \qquad K_B = A + xy'$$
$$Z = Ax'y' + Bx'y'$$

(i) Sketch the logic diagram of the circuit.
(ii) Tabulate the state table.
(iii) Derive the state equations for A and B.

QUESTION FIVE (*25 marks*)

(a) (5 pts) A *PN* flip-flop has four operations: clear to 0, no change, complement, and set to 1, when inputs P and N are 00, 01, 10, and 11, respectively. Tabulate the characteristic table and derive the characteristic equation.

(b) (5 pts) Briefly describe the basic building blocks of Algorithmic State Machine (ASM) chart.

(c) 15 pts) Draw an ASM chart and state transition table for the following state diagram.