UNIVERSITY OF ESWATINI

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIGITAL SYSTEMS

COURSE CODE – EEE323

MAIN EXAMINATION

DECEMBER 2018

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.

DO NOT OPEN THIS PAPER UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR.

QUESTION ONE *(25 marks)*

(a) (8 pts) Perform subtraction on the following unsigned binary numbers using 1's and 2's complement of the subtrahend.

(i) $11010 - 1101$

(ii) $1000 - 110000$

(b) (6 pts) Find the maxterm expansion for $F = xy + x'z$.

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

(d) (6 pts) Represent decimal 6137 in

(i) BCD

(ii) Excess-3 code

(iii) 6311 code

QUESTION TWO *(25 marks)*

a) (10 pts) For the function $f(A, B, C, D) = \sum(1,3,7,11,15)$, $d(A, B, C, D) = \sum(0,2,5)$,

(i) find a minimum sum-of-products expression,

(ii) Find a minimum product-of-sums expression.

b) (6 pts) Indicate how a NOR gate can be used to implement:

(i) An Inverter:

(ii) An OR Gate:

(iii) An AND Gate:

c) (9 pts) Implement the following Boolean function F, together with the don't-care conditions d, using no more than two NOR gates:

$$F(A, B, C, D) = \sum(2, 4,6, 10, 12)$$
$$d(A, B, C, D) = \sum(0,8,9, 13)$$

Assume that both the normal and complement inputs are available.

QUESTION THREE *(25 marks)*

(a) (7 pts) Implement the following Boolean function with a multiplexer:

$$F(A, B, C, D) = \sum(0, 1, 3,4,7,12,13,14)$$

(b) (8 pts) Draw a NAND logic diagram that implements the complement of the following function:

$$F(A, B, C, D) = \sum(0,1,2, 3,6, 8,10, 11, 14)$$

(c) (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.

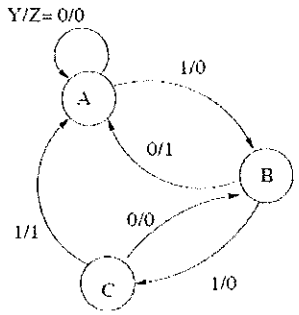
(d) (5 pts) Write the characteristic equations and the excitation tables for D, T and JK flip-flops.

QUESTION FOUR *(25 marks)*

(a) (7 pts) Design a half-subtractor circuit with inputs x and y and outputs D and B. The circuit subtracts the bits $x - y$ and places the difference in D and the borrow in B.

(b) (10 pts) Design a full-subtractor circuit with three inputs x , y , z and two outputs D and B. The circuit subtracts $x - y - z$, where z *is* the input borrow, B is the output borrow, and D *is* the difference.

(c) (8 pts) Convert the state diagram of figure below to ASM chart.



QUESTION FIVE *(25 marks)*

(a) (5 pts) Explain the difference between a **Moore** machine and a **Mealy** machine. Draw a block diagram indicating the structure of a general state machine. Indicate on the diagram where one can find the **present state** and **next state**.

(b) 10 pts.) Design a counter with T flip-flops that goes through the following binary repeated sequence: 0, 1, 3, 7, 6, 4.

(c) (10 pts) A sequential circuit has two *JK* flip-flops A and B and one input x. The circuit is described by the following flip-flop input equations:

$$J_A = x, \quad K_A = B$$
$$J_B = x, \quad K_B = A'$$

(i) Derive the state equations A^+ and B^+ by substituting the input equations for the J and K variables.

(ii) Draw the state diagram of the circuit. You must tabulate state table first.