UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIGITAL SYSTEMS/I

COURSE CODE – EEE323/EE322

MAIN EXAMINATION

DECEMBER 2017

DURATION OF THE EXAMINATION - 3 HOURS

INSTRUCTIONS TO STUDENTS

1. There are SIX questions in this paper.
2. For Students taking **EE322**, answer QUESTION FIVE and any THREE from the first FOUR questions.
3. For Students taking **EEE323**, answer QUESTION SIX and any THREE.
4. Each question caries 25 marks.
5. Show all your steps clearly in any calculations/work.
6. Start each new question on a fresh page.
7. Make sure that this exam contains 4 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 2's complement of the subtrahend.

(i) 11010 − 1101

(ii) 100 − 110000

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

Decimal	Binary	Octal	Hexadecimal
31.25			
			3A.D
	110.011		

(c) (8 pts) Represent decimal 5137 in

(i) BCD

(ii) Excess-3 code

(iii) 2421 code

(iv) 6311 code

QUESTION TWO (*25 marks*)

a) (8 pts) Express the following functions in a sum of minterms and a product of maxterms.

(i) $F(A,B,C,D) = (CD + B'C + BD')(B + D)$

(ii) $F(x,y,z) = (x' + y)(y' + z)$

b) (8 pts) Simplify the following Boolean functions using the don't-care conditions d, in (1) sum of products and (2) product of sums:

(i) $F = A'B'D' + A'CD + A'BC$

$d = A'BC'D + ACD + AB'D'$

(ii) $F = B'C'D' + BCD' + ABC'D$

$d = B'CD' + A'BC'D$

c) (9 pts) With the use of k-map, find the simplest form in sum of products of the function $F = fg$, where f and g are given by:

$$f = wxy' + y'z + w'yz' + x'yz'$$

$$g = (w + x + y' + z')(x' + y' + z)$$

QUESTION THREE (*25 marks*)

a) (7 pts) Implement the following Boolean function with a multiplexer:
$F(A,B,C,D) = \sum(0,1,3,4,12,13,15)$

b) (7 pts) Draw a NAND logic diagram that implements the complement of the following function:
$F(A,B,C,D) = \sum(0,1,2,3,6,10,11,14)$

c) (4 pts) Determine the maxterm expansion for $F = xy + x'z$.

d) (7 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 FOUR (*25 marks*)

(a) (5 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) (10 pts.) The majority circuit is a combinational circuit whose output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise. Design a 3 input majority circuit using NAND gates.

QUESTION FIVE (*25 marks*)

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

(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:

$$J_A = Bx + B'y' \qquad K_A = B'xy'$$

$$J_B = A'x \qquad K_B = A + xy'$$

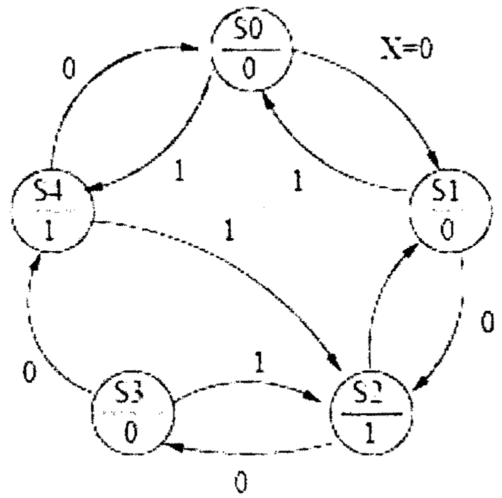
$$Z = Axy + Bx'y'$$

(i) Tabulate the state table.

(ii) Derive the state equations for A and B.

QUESTION SIX (*25 marks*)

Complete the design for the state machine described in the state diagram below.



(i) Write out the state table. Assign states using a simple binary order (S0= AB=00), Then write out the transition table.

(ii) Write out the flip-flop input excitation table assuming JK-flip flops are used.

(iii)Sketch the circuit diagram.

(iv)Is this Moore or Mealy Machine?