UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF PHYSICS

MAIN EXAMINATION 2017/18

TITLE OF PAPER: DIGITAL ELECTRONICS

COURSE NUMBER: P411

TIME ALLOWED: 3 HOURS

INSTRUCTIONS: ANSWER ANY FOUR OUT OF FIVE QUESTIONS.

EACH QUESTION CARRIES 25 MARKS.

MARKS FOR DIFFERENT SECTIONS ARE SHOWN ENCLOSED IN SQUARE BRACKETS.

THIS PAPER HAS SEVEN (7) PAGES INCLUDING THIS PAGE.

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QUESTION 1

a) Assuming that all numbers are 16bits wide, complete the missing entries which are not shaded in the following table, Table 1. Show how the solution is derived. [8]

Decimal	Hexadecimal	Binary	BCD
?	7199		
?			1000011110010010
	27ED	?	
13.375		?	

Table 1

b) Subtract $2B6D.5_{16}$ from $5A6E.2_{16}$. [4]

c) Subtract 101001_2 from 1001111_2 using 2's complement arithmetic. [4]

d) (i) Find the Gray code equivalent of decimal 14 and [2]

(ii) the decimal equivalent of Gray code number 1100. [2]

e) Give brief statements that would help one remember the truth table of AND, NAND, OR, NOR, and EX-OR logic gate functions, irrespective of the number of inputs used. [5]

QUESTION 2

a) Draw logic implementation of an inverter using (i) two-input NOR, (ii) two-input EX-OR. [4]

b)

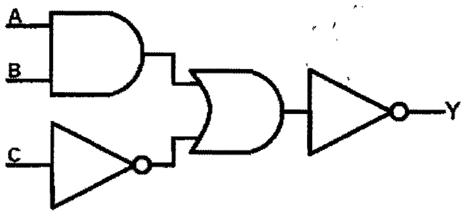


Figure 2.1

i) What is the logic function, Y, of the circuit in Figure 2.1 above? [4]

ii) Further draw the circuit diagram for the same function Y using one set of universal gates. [6]

c) Simplify the following expressions using Boolean algebra

i. $F = \bar{A}\bar{B}(\bar{A}B\bar{C} + \bar{A}\bar{B}C)$ [3]

ii. $F = \overline{(XY + XZ)}$ [3]

d) Convert the following Boolean expression into its canonical POS or maxterm form

$F = (\bar{A} + B)(\bar{A} + B + \bar{C} + \bar{D})$ [5]

QUESTION 3

a) Write the simplified minterm Boolean expression for the Karnaugh Map below.

[6]

F =

C \ AB	00	01	11	10
0	1	1	0	1
1	1	1	0	1

b) What are 'Don't cares' and how are they useful in the simplification of Boolean expressions? Give an example. [5]

c) Design a combinational logic circuit which has one output *Z* and a 4-bit input *ABCD* representing a binary number. *Z* should be 1 if the input is at least 5, but is no greater than 11. Use one OR gate (three inputs) and three AND gates (with no more than three inputs each). [8]

d) Give the truth table and Boolean expressions for a full adder. [6]

QUESTION 4

a) Design and give the truth table of a four line to two line priority encoder with active high inputs and active high outputs. Priority is assigned to the higher-order data input line. [6]

b) How do combinational logic circuits differ from sequential logic circuits? Give two examples of each category. [5]

c) Complete the following timing diagram for the flip-flop of Figure 4.1. [4]

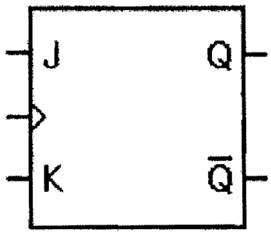
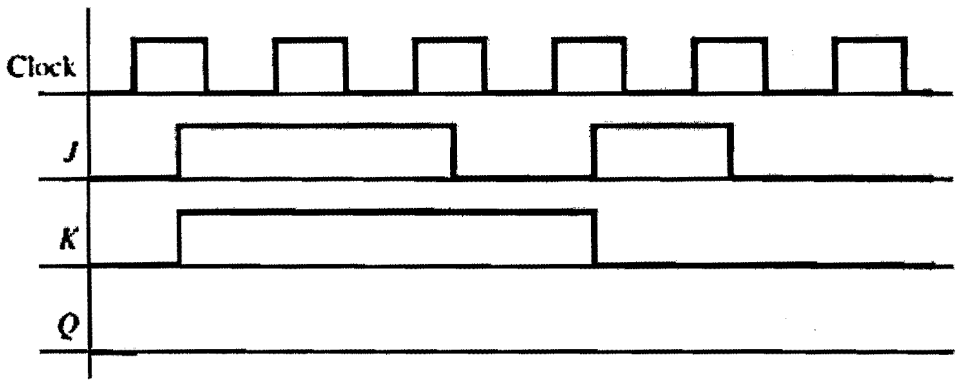


Figure 4.1



d) Draw the logic symbol of the flip-flop represented by the function table; [4]

PR	CLR	CLOCK	J	K	Q(n+1)	Q'(n+1)
1	0	X	X	X	1	0
0	1	X	X	X	0	1
1	1	X	X	X	Unstable	
0	0	↑	0	1	1	0
0	0	↑	1	0	0	1
0	0	↑	1	1	Q(n)	Q'(n)
0	0	↑	0	0	Toggle	

e) With the help of a schematic arrangement, explain how a J-K flip-flop can be used as a
  i) a D flip-flop and [3]
  ii) a T flip-flop. [3]

QUESTION 5

a) What is a magnitude comparator? [4]

b) What are the main uses of shift registers and the 4 types of registers? [6]

c) Determine the number of flip-flops required to construct a MOD-10 Ring counter: Also, write the count sequences. [6]

d) Determine the resolution in millivolts of an 8-bit D/A converter having a full-scale analogue output voltage of 5V. [5]

e) A 12-bit D/A converter has a resolution of 2.44 mV. Determine its analogue output for a digital input of 111111111111. [4]

Postulates and Theorems of Boolean Algebra		
Postulate 2	(a) $x + 0 = x$	(b) $x \cdot 1 = x$
Postulate 5	(a) $x + x' = 1$	(b) $x \cdot x' = 0$
Theorem 1	(a) $x + x = x$	(b) $x \cdot x = x$
Theorem 2	(a) $x + 1 = 1$	(b) $x \cdot 0 = 0$
Theorem 3, involution	$(x')' = x$	
Postulate 3, commutative	(a) $x + y = y + x$	(b) $xy = yx$
Theorem 4, associative	(a) $x + (y + z) = (x + y) + z$	(b) $x(yz) = (xy)z$
Postulate 4, distributive	(a) $x(y + z) = xy + xz$	(b) $x + yz = (x + y)(x + z)$
Theorem 5, DeMorgan	(a) $(x + y)' = x'y'$	(b) $(xy)' = x' + y'$
Theorem 6, absorption	(a) $x + xy = x$	(b) $x(x + y) = x$

END OF P411 MAIN EXAMINATION