higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T410(E)(A16)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

DIGITAL ELECTRONICS N4

(8080354)

16 April 2015 (Y-Paper)
13:00–16:00

Calculators may NOT be used.

This question paper consists of 5 pages.

ENGINEERING

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
DIGITAL ELECTRONICS N4
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. All conversions and calculations must be clearly shown.
5. All sketches and diagrams must be neat and labelled.
6. Keep subsections of questions together.
7. Write neatly and legibly.

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QUESTION 1

1.1 Write down the radix of the HEXADECIMAL number system. (1)

1.2 Write down the symbols of the DECIMAL number system. (1)

1.3 How many input combinations can be used on a TWO input NAND gate? (1)

1.4 Name any WEIGHED non-inverting code. (1)

1.5 Give the symbol, truth table and Boolean expression of the XOR (exclusive OR) gate. (3)

1.6 Write down the simplest form of the following Boolean expressions below:

1.6.1 $A + \overline{A}BC + \overline{\overline{A}BC} = F$

1.6.2 $1 + \overline{B}C + \overline{A}BC = F$

1.6.3 $A\overline{BC} + A\overline{BC} + \overline{BC} = F$

1.6.4 $\overline{A}B + A\overline{B} = F$

(4 × 1) (4)

1.7 What will be the output state on Q of a JK master-slave flip-flop when clocked with both J and K held at binary 1? (1)

1.8 Convert 110011_2 to the GRAY code. Show the method of conversion that you used. (2)

1.9 Briefly explain why the synchronous binary counter is faster than the asynchronous binary counter. (2)

1.10 Draw the symbol and truth table for the following flip-flops:

Also indicate the external connections needed to make them toggle.

1.10.1 JK master-slave

1.10.2 RS master-slave

1.10.3 D-type

(3 × 3) (9)

[25]

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QUESTION 2

2.1 Do the following calculations in the binary number system. Clearly show all conversions and calculations.

2.1.1 $7{,}5_8 - 9{,}B_{16}$

Use the ONE's complement method and convert the final answer to the DECIMAL number system.

2.1.2 $14{,}25_{10} \times 6{,}4_8$

Convert the final answer to the HEXADECIMAL number system.

2.1.3 $3A{,}E_{16} \div 9{,}5_{10}$

Convert the final answer to the OCTAL number system.

(3 × 6) (18)

2.2 Write $4{,}75_{10}$ in the following BINARY codes.

2.1.1 2421 BCD

2.1.2 Excess-3 BCD

(2 × 3) (6)
[24]

QUESTION 3

3.1 Draw the circuit diagrams of the following Boolean expressions. Do NOT change or simplify the expressions:

3.1.1 $\overline{\overline{XYZ} + \overline{\overline{YZ}} + \overline{\overline{XY}}} = F$

3.1.2 $\overline{\overline{XY} \oplus Z} \oplus \overline{X}YZ = F$

3.1.3 $\overline{\overline{XY} + \overline{\overline{XY}}} + \overline{\overline{X} + \overline{\overline{YZ}}} = F$

(3 × 5) (15)

3.2 Simplify the following expressions with Boolean algebra.

Draw the simplified circuit diagrams using ONLY NAND gates.

3.2.1 $\overline{\overline{C(A + \overline{B}) + A(B + \overline{\overline{C}})(\overline{\overline{AB}})}} = F$

3.2.2 $\overline{\overline{\overline{A + \overline{B}} + B} + \overline{A + \overline{\overline{A + B}}}} = F$

(2 × 6) (12)
[27]

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QUESTION 4

4.1 Draw the circuit diagram of a four-bit SYNCHRONOUS binary down counter. Show all control and input/output points. Draw the timing diagram for EIGHT clock pulses. The diagram must start with all outputs low (0). (12)

4.2 Make a neat labelled sketch of a 4 : 1 MULTIPLEXER/DEMULTIPLEXER system circuit diagram using logic gates. Clearly show all the input, output and control lines. (12)
[24]

TOTAL: 100

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MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

DIGITAL ELECTRONICS N4

16 APRIL 2015

This marking guideline consists of 6 pages.

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QUESTION 1

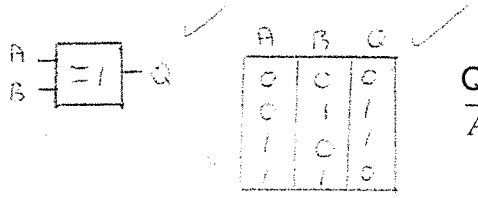
1.1 16 ✓ (1)

1.2 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 ✓ (1)

1.3 $2^2 = 4$ ✓ (1)

1.4 8421 ✓ (1)

1.5



$Q = A \oplus B$

$\overline{A}B + A\overline{B}$ (3)

1.6 1.6.1 1 ✓

1.6.2 1 ✓

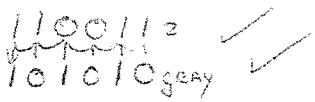
1.6.3 $\overline{BC}$ ✓

1.6.4 $A \oplus B$ ✓

(4 × 1) (4)

1.7 Toggle✓ (1)

1.8



(2)

1.9
- Synchronous: clocks all flip-flops simultaneously.✓
- Asynchronous: clocks one flip-flop after the other.✓ (2)

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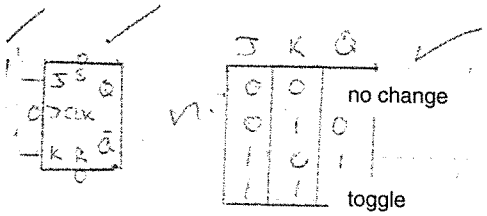
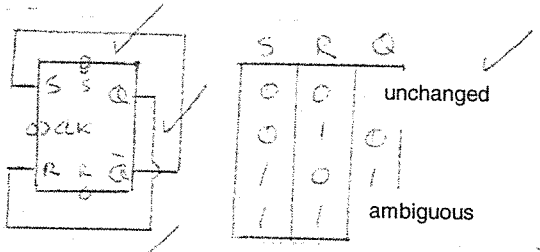
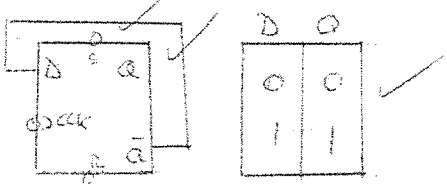
1.10 1.10.1



1.10.2



1.10.3



(3 × 3) (9)
[25]

QUESTION 2

2.1 2.1.1

$7,5_8 = 0111,101_2 \rightarrow 0\,000\,111,1010$
$9,B_{16} = 1001,1011 \xrightarrow{1's} 1\,110\,0100$
$1^{st}\ 111\,101,1110 \xrightarrow{1's} -10,0001$
$= -2,0625_{10}$

(6)

2.1.2

$14,25_{10} = 1110,01_2$
$6,4_8 = 110,100_2$

$$\begin{array}{r} 1110,01 \\ \times\ 110,1 \\ \hline 1\,1100\,1 \\ 1\,1100\,100 \\ 111\,0010\,00 \\ \hline 10\,1110\,0,101_2 = 5C,A_{16} \end{array}$$

(6)

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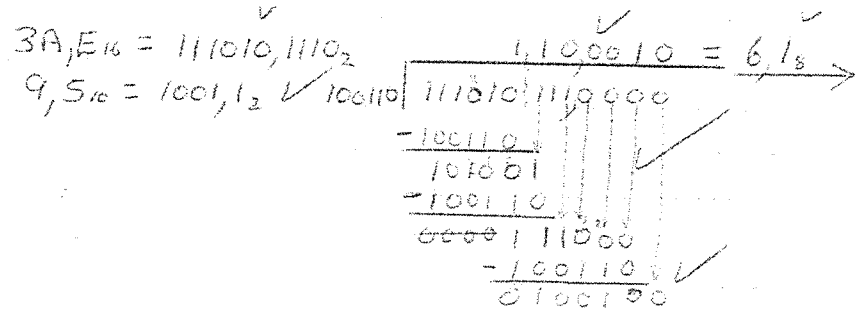
2.1.3



(6)

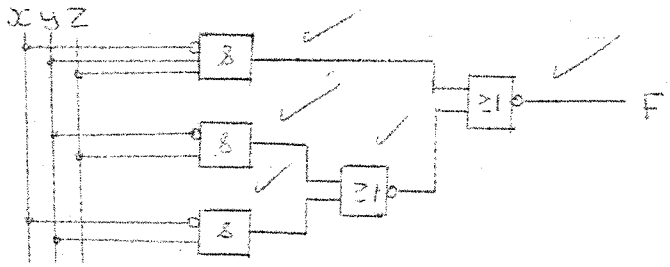
2.2 2.2.1 0100, 1101 1011_{2421}

2.2.2 0111, 1010 1000_{x3}

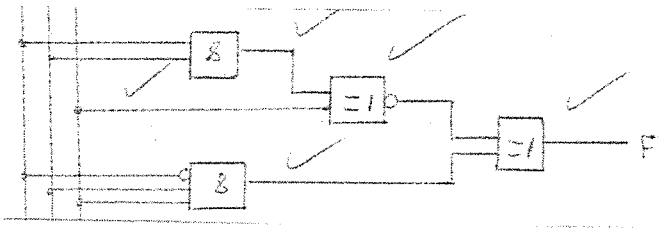
(2 × 3) (6)
[24]

QUESTION 3

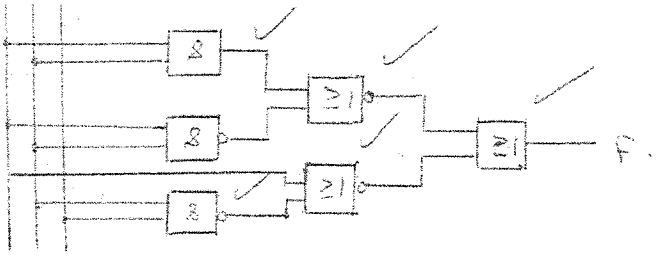
3.1 3.1.1



3.1.2



3.1.3



(3 × 5) (15)

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3.2 3.2.1

$\overline{C(A+\bar{B})+A(B+\bar{C})\cdot(\bar{A}B)} = F$

$= C(A+\bar{B})+A(B+\bar{C})+\bar{A}B$ ✓

$= AC+\bar{B}C+AB+A\bar{C}+\bar{A}B$ ✓

$= A(C+\bar{C})+B(A+\bar{A})+\bar{B}C$

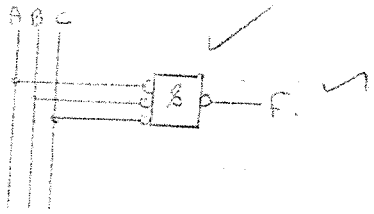
$= A+B+\bar{B}C$ ✓

$= A+B+C$ ✓

TO NANDS:

$\overline{\overline{A+B+C}}$ ✓

$= \overline{A}\cdot\overline{B}\cdot\overline{C}$



3.2.2

$\overline{\overline{A+B}+B}+\overline{A+\overline{A+B}}$

$= \left(\overline{\overline{A+B}+B}\right)\cdot\left(\overline{A+\overline{A+B}}\right)$ ✓

$= \left(\overline{A+B}+B\right)\cdot\left(A+\overline{A+B}\right)$ ✓

$= \left((\bar{A}\bar{B})+B\right)\cdot\left(A+(\bar{A}\bar{B})\right)$ ✓

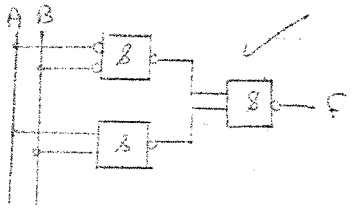
$= (\bar{A}\bar{B}+AB)$

$= \bar{A}\bar{B}+AB$ ✓

TO NANDS:

$\overline{\overline{\bar{A}\bar{B}}\cdot\overline{AB}}$ ✓

$= \bar{A}\bar{B}\cdot AB$



(2 × 6) (12)

[27]

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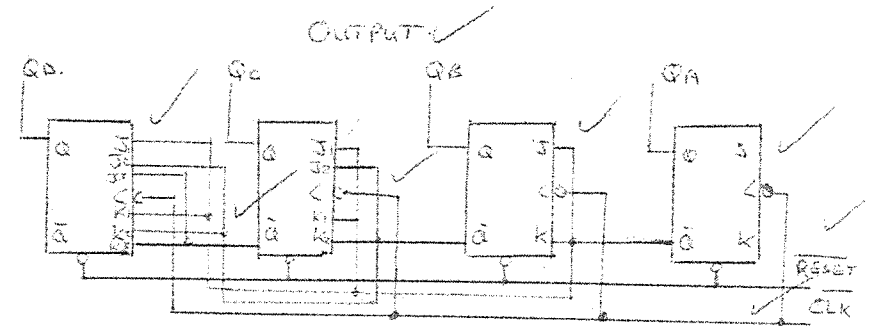
QUESTION 4

4.1



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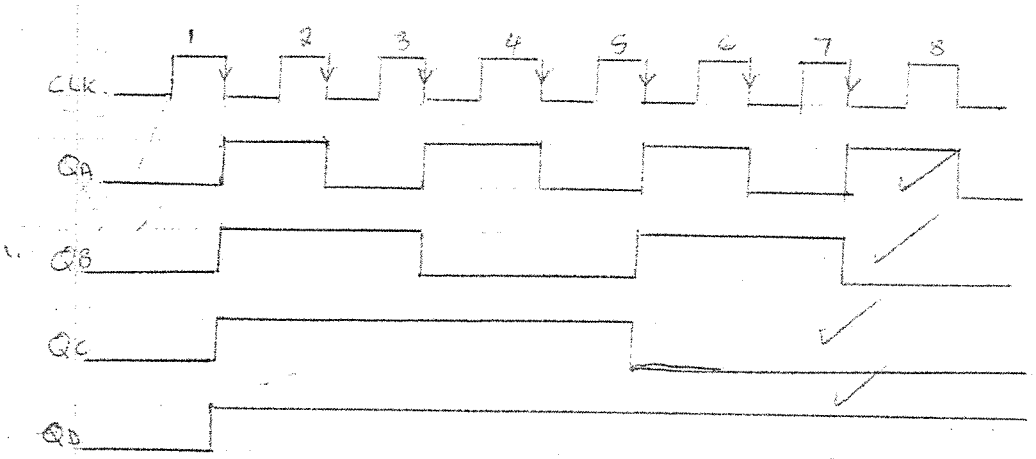
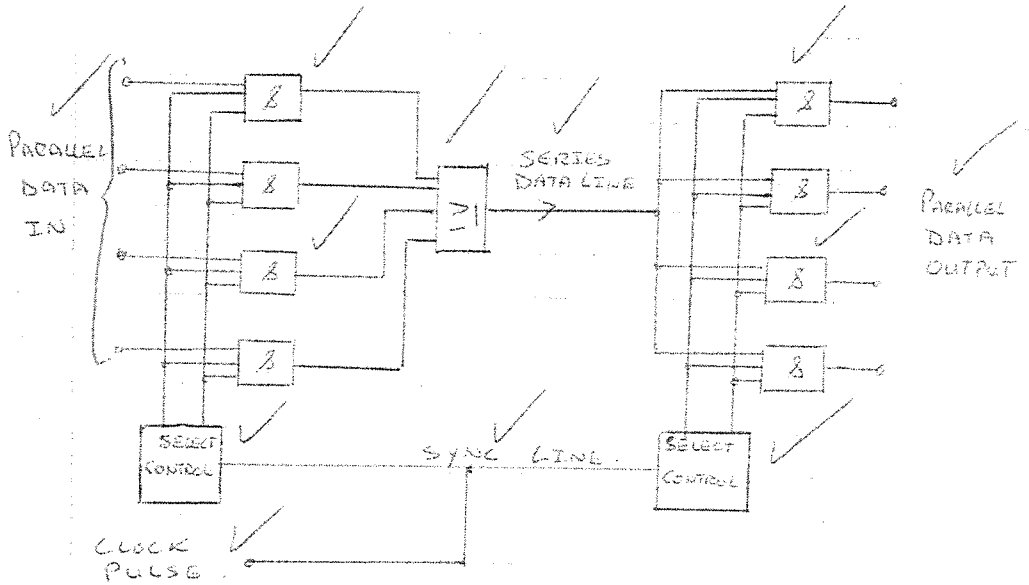


(4)

4.2



(12)
[24]

TOTAL: 100

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