higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T390(E)(J21)T

AUGUST EXAMINATION

NATIONAL CERTIFICATE

DIGITAL ELECTRONICS N4

(8080354)

21 July 2014 (Y-Paper)
13:00–16:00

Calculators may NOT be used.

This question paper consists of 5 pages.

ENGINEERING

Copyright reserved

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 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.

ENGINEERING

Copyright reserved

QUESTION 1

1.1 Write down the radix of the *hexadecimal* system. (1)

1.2 Write down the symbols of the *octal* system. (1)

1.3 How many input combinations can be used on a three-input NOR gate? (1)

1.4 Name any non-weighed self-inverting code. (1)

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

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

1.6.1 $ABC + AB + \overline{AB}$ = F

1.6.2 $\overline{A} + ABC + A$ = F

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

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

(4 × 1) (4)

1.7 Which ONE of the synchronous or asynchronous binary counters will count the fastest? Motivate your answer. (3)

1.8 Convert 1101001_{gray} to the BINARY code. Show your method of conversion. (2)

1.9 Draw a square wave and clearly indicate the following on the waveform:

1.9.1 Leading edge

1.9.2 Trailing edge

1.9.3 Mark period

1.9.4 Space period

(4 × 1) (4)
[20]

ENGINEERING

Copyright reserved

QUESTION 2

2.1 Do the following calculations in the binary number system. Show ALL conversions and calculations clearly.

2.1.1 $A,8_{16} - 13,75_{10}$

Use the TWO'S complement method and convert the final answer to the *octal* system.

2.1.2 $14,25_{10} \times 6,4_{8}$

Convert the final answer to the *hexadecimal* system.

2.1.3 $2E,B_{16} \div 5,75_{10}$

Convert the final answer to the *decimal* system.

(3 × 6) (18)

2.2 Write $5,76_{10}$ in the following BINARY codes:

2.2.1 8421 BCD

2.2.2 2421 BCD

2.2.3 Excess-3 BCD

(3 × 3) (9)
[27]

QUESTION 3

3.1 Draw the circuit diagrams of the Boole expressions below. Do not change or simplify the expressions:

3.1.1 $\overline{(AB + \overline{A} + \overline{B} + C)}(A + \overline{BC}) = F$

3.1.2 $\overline{(AB \oplus \overline{BC}) \oplus \overline{ABC}} = F$

3.1.3 $(ABC + \overline{ABC}) \oplus (A(\overline{BC})) = F$

(3 × 5) (15)

3.2 Simplify the expressions below with Boolean algebra. Draw the simplified circuits using ONLY NAND gates.

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

3.2.2 $\overline{\overline{(\overline{A}B + ABC)(\overline{A}BC + ABC)}\ \overline{(\overline{A}B + ABC)}} = F$

(6 × 2) (12)
[27]

ENGINEERING

Copyright reserved

QUESTION 4

4.1 Draw the circuit diagram of a four–bit series shift RIGHT register using SR master-slave flip-flops. Show ALL control and input/output points. (6)

4.2 Make a neat labelled sketch of a 4-bit RING counter. Use JK master-slave flip-flops. Draw the timing diagram for TEN clock pulses. (8)
[14]

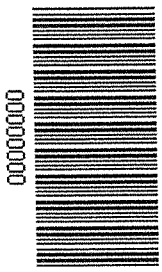
QUESTION 5

Make a neat sketch of a JK master-slave flip-flop consisting of only NAND gates. Briefly describe the FOUR most important switching points on the input clock pulse. **[12]**

TOTAL: 100

ENGINEERING

Copyright reserved





higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

AUGUST EXAMINATION

DIGITAL ELECTRONICS N4

21 JULY 2014

This marking guideline consists of 6 pages.

Copyright reserved

QUESTION 1

1.1 16 (1)

1.2. 0, 1, 2, 3, 4, 5, 6, 7 (1)

1.3 $2^3 = 8$ (1)

1.4 X-3 Excess 3. (1)

1.5 XOR



A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

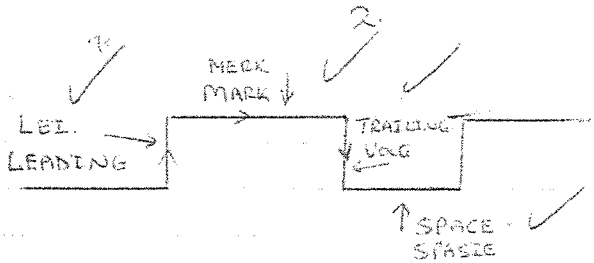
$Q = A \oplus B$
$\bar{A}B + A\bar{B}$ (3)

1.6.
1.6.1 1
1.6.2 1
1.6.3 $\overline{BC}$
1.6.4 1 (4)

1.7. Synchronous / sinkrone
(i) Synchronous clocks all flip-flops simultaneousely. (3)
Sinkrone klok alle wipkringe gesamentlik.
(ii) Asynchronous clocks one flip-flop after the previous one.
Asinkrone klok een wipkring na die ander.

1.8 1101001 gray
1001110 2. (2)

1.9.



(4)

[20]

QUESTION 2

2.1

2.1.1 $A,8_{16} = 1010,1000_2 \longrightarrow 1010,1000$

$13,75_{10} = 1101,11 \xrightarrow{2's\ COMP} 0010,0011$

$+1$

$1100,1100 \xrightarrow{2's\ C} 0011,0011$

1

$0011,0100$

$= -3,2_8$ (6)

No Carry: Get 2's Compl.
Sign neg.

2.1.2. $14,25_{16} = 1110,01_2$

$6,4_8 = 110,100$

$1110,01$

$\times 1101$

111001

11100100

111001000

$1011100,101 = 5C,A_{16}$ (6)

2.1.3 $2E,B_{16} = 101110,1011$

$5,75_{10} = 101,11$

$1000,0001$

$1011100 \overline{)101110101 1,0000}$

-1011100

10110000

$= 8,0625_{10}$ (6)

2.2

2.2.1 $0101,0111\,0110_{8421}$ (3)

2.2.2. $1011,1101\,1100_{2421}$ (3)

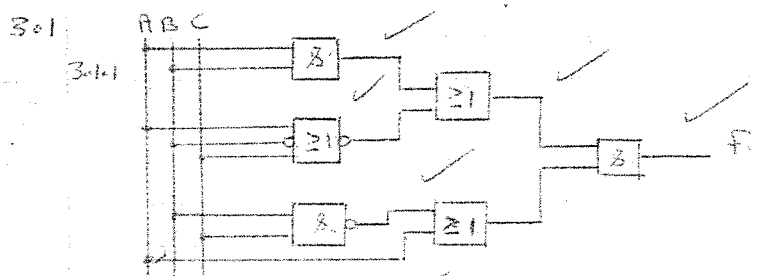
2.2.3 $1000,1010\,1001_{x+3}$ (3)

[27]

QUESTION 3

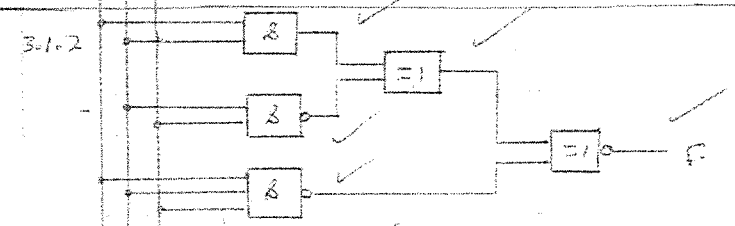
3.1

3.1.1



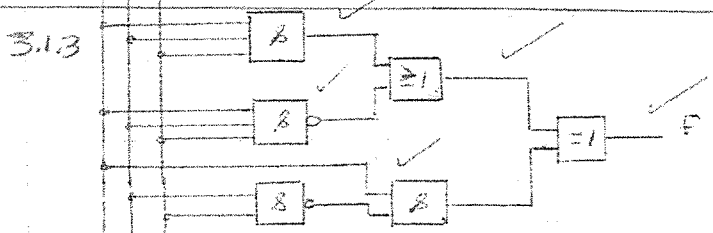
(5)

3.1.2



(5)

3.1.3



(5)

3.2

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

$= A(\bar{A}+\bar{A}B+\bar{A}C+\bar{A}\bar{B}+0+\bar{B}\bar{C}+\bar{A}C+BC+0)(\bar{A}+\bar{B}+\bar{C})$

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

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

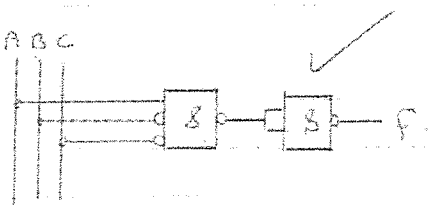
$= A(\bar{A}+\bar{B}\bar{C})$

$= 0 + A\bar{B}\bar{C}$

TO NANDS.

$\overline{\overline{A\bar{B}\bar{C}}}$

$= A\bar{B}\bar{C}$



(6)

3.2.2 $\overline{(\bar{A}B+ABC)(\bar{A}BC+ABC)(\bar{A}B+ABC)} = F$

$= (\bar{A}B+ABC)(\bar{A}BC+ABC)+(\bar{A}B+ABC)$

$= \bar{A}B+ABC$

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

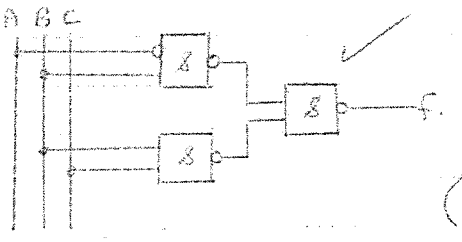
$= B(\bar{A}+C)$

$= \bar{A}B+BC$

TO NANDS.

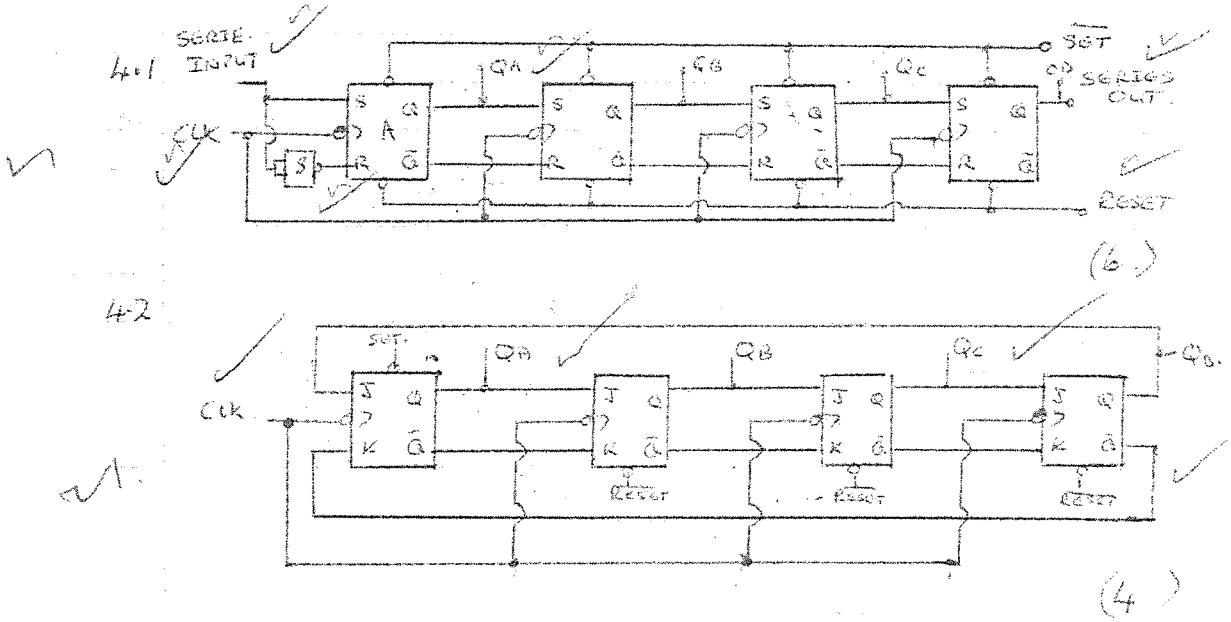
$\overline{\overline{\bar{A}B+BC}}$

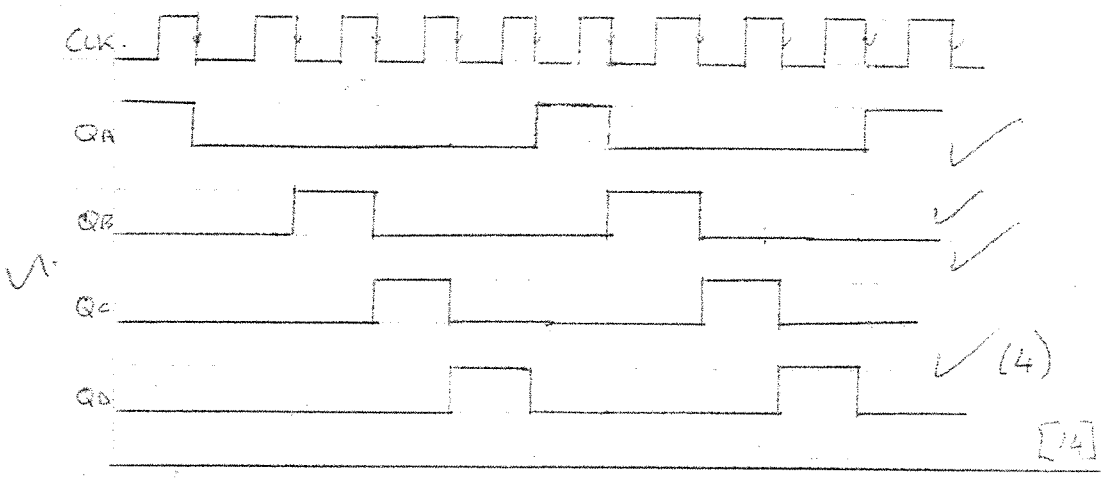
$= \overline{\bar{A}B} \cdot \overline{BC}$



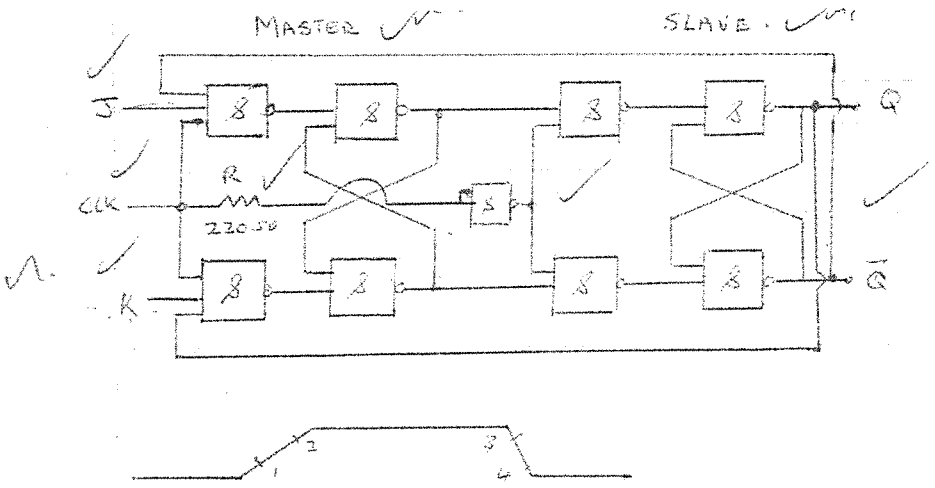
(6)

QUESTION 4


4-1
SERIE INPUT
CLK
QA
QB
QC
SET
SERIES OUT
RESET
(6)
4-2
CLK
SET
QA
QB
QC
QD
RESET
(4)


CLK
QA
QB
QC
QD
(4)
[14]

QUESTION 5



(5)

1. MASTER CLOSED. SLAVE CLOSED
   MEESTER TOE. SLAAF TOE.

2. MASTER OPEN SLAVE CLOSED
   MEESTER OOP SLAAF TOE

3. MASTER CLOSED SLAVE CLOSED
   MEESTER TOE SLAAF TOE.

4 MASTER CLOSED SLAVE OPEN
   MEESTER TOE SLAAF OOP

(4)
[12]

TOTAL [/100]

Copyright reserved