higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

DIGITAL ELECTRONICS N6

(8080376)

24 November 2023 (X-paper)
09:00–12:00

Drawing instruments may be used.

This question paper consists of 7 pages.

082Q1E2324

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
DIGITAL ELECTRONICS N6
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 sketches must be large, clear and fully labelled.
5. Write neatly and legibly.

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SECTION A

QUESTION 1

Give ONE term for each of the following descriptions by writing it next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 A code that is used in sequential counting in which only one bit changes at a time as the count progresses

1.2 An electronic circuit in chip form that changes analogue inputs into digital outputs

1.3 An electronic circuit in chip form that can be used as a pulse distributor in a central processing unit

1.4 Activity on the sun's surface that can cause disruption in satellite communication

1.5 The technical term for starting a computer up

(5 × 1) **[5]**

QUESTION 2

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (2.1–2.5) in the ANSWER BOOK.

2.1 Which ONE of the following interrupts has to be attended to immediately?

A Internal
B External
C Priority
D Non-maskable

2.2 A system in which several data inputs are interfaced with a computer:

A Frequency shifted keying
B Data acquisition system
C The Seebeck effect
D The operating system

2.3 Which ONE of the following is the solution for Ā.B.1 + 0?

A Ā
B B
C Ā.B
D 1

2.4 The Gray equivalent of the binary number 11001_2 is …

A 10101_{GRAY}
B 10110_{GRAY}
C 10001_{GRAY}
D 10111_{GRAY}

2.5 The binary equivalent of $0101\ 1100_{xs-3}$ is …

A 11000_2
B 10010_2
C 11101_2
D 01111_2

(5 × 1) **[5]**

QUESTION 3

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–H) next to the question number (3.1–3.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.1	A graphical representation of the steps involved in finding the solution to a given problem	A	data selection
3.2	A high-level business language	B	COBOL
3.3	A high-level scientific language	C	quantising error
3.4	The difference between analogue input and digital output	D	BASIC
3.5	A standard microprocessor used in most current computers	E	data routing
		F	FORTRAN
		G	flow chart
		H	Pentium

(5 × 1) **[5]**

QUESTION 4

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (4.1–4.5) in the ANSWER BOOK.

4.1 The absorption rule in Boolean algebra can be described by the following identity:

D.E + D.F = D(E + F)

4.2 A computer is said to be on-line if it is switched on.

4.3 If data is processed as it is entered, the system is said to operate in real time.

4.4 A stepping motor switch is associated with data routing.

4.5 The step voltage on a digital to analogue converter refers to the voltage on the output when all inputs are high.

(5 × 1) **[5]**

TOTAL SECTION A: 20

SECTION B

QUESTION 5

5.1 A calculator is designed to have a five-bit opcode. What is the maximum number of functions that the calculator could have? (1)

5.2 A computer numeric control (CNC) system can be used to shape an object to preset specifications.

5.2.1 Draw a fully labelled diagram of a CNC system that could perform this task. (7)

5.2.2 Briefly describe how this CNC system would function. (3)

5.3 What is meant by *real-time processing*? Name any TWO applications of real-time processing. (2)

[13]

QUESTION 6

6.1 Draw a block diagram of a complete four-input data acquisition system. The system must incorporate a random-access memory, thereby making it a more efficient system than if it had three-state drivers. (8)

6.2 The following data packages are transmitted using PCM (pulse-coded modulation) that uses NRZ (non-return-to-zero):

0101 1110 1110 0111

Graphically using all four bits in the string, show clearly how the transmission would look. (4)

6.3 Write the following abbreviations or acronyms out in full:

6.3.1 USART

6.3.2 CPU

6.3.3 ALU

(3 × 1) (3)

6.4 A six-bit analogue to digital converter produces an output of 000001_2 when 10 mV is applied to its input.

6.4.1 Calculate the full-scale voltage of the analogue to digital converter.

6.4.2 Calculate the output when 0,5 V is applied to the input.

(2 × 2) (4)

[19]

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QUESTION 7

7.1 Control units vary from one computer to another. Base your answer on the Von Neumann architecture where a common RAM holds all data and program instructions, necessitating a fetch/execute routine.

Draw a fully labelled block diagram of a control unit integrated with a RAM that is driven by a six-bit ring counter. All the gates and interconnections between the registers must be included. (10)

7.2 The decoder in the block diagram in QUESTION 7.1 has the following instruction set:

INSTRUCTION	OPCODE
LDA	0010
ADD	1000
SUB	1001
STA	0011
STP	0000

Draw a detailed circuit, going down to gate level, that shows all the decoder connections. (5)

7.3 When certain instructions such as LDA and STA are executed, the last pulse is called a 'do-nothing' phase. Why is this so? (3)
[18]

QUESTION 8

8.1 Consider the following FORTRAN program segment:

```
      JIM = 14
      MORRISON = 9
21100 DOORS = JIM + MORRISON
      JIM = JIM + 7
      IF (DOORS.LT.40) GOTO 21100
      MORRISON = MORRISON + 7
      PRINT JIM, MORRISON
      PRINT DOORS
      STOP
      END
```

Draw a table with the following headings: PASS, JIM, MORRISON, DOORS. Now clearly show how each value changes with each successive pass. Finally, beneath the table, show clearly what the final printout will look like. (10)

8.2 The following is a section of a program in machine code:

INSTRUCTION #	OPCODE	ADDRESS	DESCRIPTION
0000	0011	1001	LDA
0001	0111	1010	ADD
0010	0111	1101	ADD
0011	0111	1100	SUB
0100	0110	1100	SUB

The following are the address contents to which the above program refers:

ADDRESS	ADDRESS CONTENTS
1001	55_{16}
1010	55_{16}
1011	11_{16}
1100	44_{16}
1101	55_{16}

Rewrite each instruction number one below the other and next to it clearly show the accumulator contents after each instruction is completed. (5)
[15]

QUESTION 9

9.1 The following word is received in Hamming code. By showing all the steps involved, find the fault in the word, clearly state the bit number on which the fault lies and then rewrite the correct word clearly indicating which bit has been corrected.

1 1 0 0 1 0 1 1 0 0 hamming (7)

9.2 Write the following floating-point numbers in decimal, showing all your steps:

9.2.1 0 101 0 1111000 (3)

9.2.2 0 101 1 1111000 (3)

9.3 Simplify the following Boolean problem:

A + C + AB + BC + ABC (2)
[15]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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