higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

DIGITAL ELECTRONICS N6

(8080376)

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Drawing instruments may be used

This question paper consists of 6 pages.

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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. Start each section on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.

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QUESTION 1: COMPUTER SYSTEMS

Computers are commonly used in industry to control analogue devices. Read the following scenario very carefully and answer the questions that follow.

A large industrial furnace is to have its temperature controlled from a computer. Because the furnace heats up to a very high temperature, the control room in which the computer is housed is situated remotely at the far end of the industrial plant. The computer must control two valves, the first to cool the furnace should it go above a specified temperature of 950°C. The second valve activates a much larger flow of coolant should the furnace temperature continue to rise even though the first valve is open. Once the temperature stabilizes and drops below 800°C the valves must be switched off.

1.1 State what type of transducer could be used to measure the temperatures that are required as triggers for the computer. (1)

1.2 Would the loop towards the computer be described as the feedback loop or as the action loop? (1)

1.3 Draw a fully labelled block diagram to describe the digital process control system that would be used to accomplish the above task. ALL elements in the system must be included AND clearly labelled. All signal directions must be shown as well. (12)

1.4 Another type of computer control is that of numeric control. Draw a fully labelled diagram of a computer numeric control (CNC) system that would be used in a profile cutting production system. (6)

[20]

QUESTION 2: TRANSMISSION, DATA AND ASSOCIATED HARDWARE

2.1 What is the basic function of a data acquisition system? (4)

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

1101 1101 1110 0011

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

2.3 A multiplexer (mux) is a versatile piece of hardware. Aside from multiplexing, name FIVE other applications it can serve in a digital system. (5)

2.4 Write down in full the meaning of each letter of the following acronyms:

2.4.1 CPU

2.4.2 USB

2.4.3 ALU

(3 × 1) (3)

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2.5 The following elements form part of the input/output circuits of digital computers. Briefly explain the function and application of each element.

2.5.1 Programmable Peripheral Interface (PPI)

2.5.2 Programmable Interface Adapter (PIA)

(2 × 2) (4)
[20]

QUESTION 3: COMPUTER ARCHITECTURE

3.1 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 and an execute routine.

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

3.2 The six pulses that are generated by the ring counter in QUESTION 3.1 are divided into two phases or routines.

Name these phases. (2)

3.3 The decoder in the block diagram of QUESTION 3.1 has the following instruction set:

INSTRUCTION	OP-CODE
LDA	1010
ADD	1001
SUB	0101
STA	0000
STP	1111

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

3.4 When certain instructions such as LDA and STA are executed, the last pulse is called a 'do-nothing' phase. Why is this so? (3)
[20]

QUESTION 4: HIGH LEVEL PROGRAMMING

4.1 Consider the following FORTRAN program segment.:

```
      AMOS = 15
      BJORK = 8
22002 HARVEY = AMOS + BJORK
      BJORK = BJORK + 7
      IF (BJORK.LT.40) GO TO 22002
      PRINT, HARVEY, BJORK, AMOS
      STOP
      END
```

Draw a table with the following headings: AMOS, BJORK and HARVEY. Now clearly show how each value changes. Finally, beneath the table, show clearly what the final printout will look like. (10)

4.2 The program in QUESTION 4.1 was written in FORTRAN. What does the acronym FORTRAN stand for? (1)

4.3 The following is a section of a program in machine code.

INSTRUCTION #	OP-CODE	ADDRESS	DESCRIPTION
0000	0011	1001	LOAD ACCUMULATOR
0001	0111	1010	ADD
0010	0110	1101	SUB
0011	0111	1100	ADD
0100	0110	1011	SUB

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

ADDRESS	ADDRESS CONTENTS
1001	55_{16}
1010	66_{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)

4.4 When a program is executed it can either be real-time or it can be batch-processed.

4.4.1 State the difference between the two.

4.4.2 Give one real-world example of each.

(2 × 2) (4)

[20]

QUESTION 5: NUMBER SYSTEMS

5.1 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.

$0000011010_{hamming}$ (7)

5.2 Write the following floating point numbers in decimal, showing all your steps.

5.2.1 **0 100 0 11110000** (3)

5.2.2 **0 010 1 101100000** (3)

5.3 Solve the following using Boolean Algebra:

F = A.B.B.C + C + B.C (2)

5.4 Rewrite the following binary number in the Gray Code:

1100001_2 (2)

5.5 Rewrite the following binary coded decimal (8.4.2.1) in the 2.4.2.1 code:

$0101\ 0100\ 1001_{8.4.2.1}$ (2)

5.6 State the underlying reason why the binary system was used instead of any other system in digital devices.

(1)
[20]

TOTAL: 100

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