higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

LOGIC SYSTEMS N6

(8080306)

7 April 2021 (X-paper)
09:00–12:00

Nonprogrammable calculators and 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
LOGIC SYSTEMS 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. Diagrams should be large, clear and neat and may be done in pencil.
5. Use only a black or blue pen.
6. Write neatly and legibly.

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NOTICE TO CANDIDATES

The lives and safety of people depend on logic systems. Logic systems prevent lift doors from crushing persons to death or aircraft from colliding in the air. Logic signalling systems prevent trains from colliding. Logic systems keep people safe in buildings and in hospital intensive-care units. Your work, programming and designs, must be properly planned and presented at this Diploma exit-level examination. Standards must be maintained for the safety of the public.

QUESTION 1

Indicate whether the following statements are TRUE or FALSE by writing 'True' or 'False' next to the question number (1.1–1.10) in the ANSWER BOOK. Give a reason for the answer.

1.1 A bipolar RAM cell uses MOSFETS in its construction.

1.2 Static and dynamic MOS memory cells consume the same amount of power.

1.3 COBOL is classified as a high-level programming language.

1.4 A USB port on your laptop computer is also an A/D converter.

1.5 The series D/A converter uses an operational amplifier.

1.6 The computer mouse is an output device from the computer as it can be moved by the operator.

1.7 A Schmitt trigger circuit will convert a square-wave input to a sine-wave output.

1.8 An 8-bit address bus would be able to address 256 addresses.

1.9 An assembler allows a person to write programs in mnemonic form.

1.10 An interrupt is serviced differently from a subroutine.

(10 × 2) **[20]**

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QUESTION 2

2.1 Draw a large, neat, fully labelled diagram of an operational amplifier configured as a comparator. The operational amplifier is used to control the level of liquid in a tank.

Show the connections to the sensor(s) and actuator(s) required to control the level. Show the signal directions. Show any analogue-to-digital or digital-to-analogue converters that may be needed. Fully integrate the control circuitry with the objects which are being controlled.

Briefly describe the method of operation. (10)

2.2 You are tasked to replace the above analogue system with a digital computerised process. Draw a large, neat, fully labelled block diagram to show the interfacing of input/output ports of a computer. The computer is used to control the level of liquid in a tank.

The labels of the block diagram must appear on the block diagram itself. Clearly show the configuration of each input/output port. All interfacing and process functions needed to monitor and control the level must be shown. Show signal directions. Show the interfacing of sensor(s) and actuator(s). Label the feedback and action loops. (10)

[20]

QUESTION 3

3.1 Most computers use a bus structure or system to link the various components within the system.

Name THREE different types of busses and make a sketch clearly showing the connections and directions of these three busses in a simple computer system. (8)

3.2 Computers store large amounts of data in hard disk drives. When multiple disk drives are connected to a computer, either radial interfacing or daisy chain interfacing can be used.

Draw a small block diagram to illustrate how each of the following interfacing is done on 3 external disk drives.

3.2.1 Radial interfacing

3.2.2 Daisy chain interfacing

(2 × 5) (10)

[18]

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QUESTION 4

4.1 PROGRAMMING INSTRUCTION PROCEDURE

The following instruction set is available:

OPCODE	DESCRIPTION
LOAD	Load accumulator
ADDA	Add to accumulator
SUBT	Subtract from accumulator
MULT	Multiply
BRAN	Branch if the accumulator is negative
BRAP	Branch if the accumulator is positive
STOR	Store
OUTP	Output the contents of the accumulator
HALT	Halt (non-memory referenced instruction)

Note the following specification and information when writing the program:

- All mathematical operations done before coding, must be shown.
- The first program address with which the program counter is loaded is BCCA (HEXADECIMAL).
- Case sensitivity: Operands must be lower case.
- Case sensitivity: Addresses must be upper case.
- You may NOT enlarge the instruction set.
- The program must stop processing if, after any mathematical operation, the contents of the accumulator is POSITIVE. (**NOTE:** POSITIVE)
- The correct delimiter must be used after delivering the output so that memory use is limited to program lines.

The operands r, s, t, u v, w, x, y and z are stored in consecutive hexadecimal addresses:

Operand r is stored in address F1B1
Operand s is stored in address F1B2
Operand t is stored in address F1B3
Operand u is stored in address F1B4 - and so on.

The correct programming fields appear below:

INSTRUCTION LOCATION	INSTRUCTION WORD		DESCRIPTION
	OPCODE	ADDRESS	

Use the correct programming fields to write a program to calculate the value of z if:

z = t + uv (10)

4.2 Logic systems engineers must be able to use digital-to-analogue converters to control certain types of instrumentation.

Draw a schematic diagram of a weighed resistor-type digital-to-analogue converter that can convert a 3-digit BCD (binary-coded decimal) to an equivalent analogue output voltage. Make use of an operational amplifier and use THREE separate reference voltage sources. Clearly show the ratios and resistor values of the resistors used in the circuit. The largest resistor in the weighed resistor ladder has a value of 100 kilohms and the feedback resistor on the operational amplifier has a value of 10 kilohms. (15)
[25]

QUESTION 5

5.1 The stack plays an important part in microprocessor program control.

Briefly describe where and why the stack is used. (5)

5.2 Microprocessors can make use of subroutines in programmes.

Briefly explain the purpose and use of a subroutine. (5)

5.3 You are required to design a 2-bit analogue-to-digital flash converter.

Calculate the number of comparators that are required to build this flash converter and make a labelled design sketch. (7)
[17]

TOTAL: 100

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