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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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APRIL EXAMINATION

NATIONAL CERTIFICATE

LOGIC SYSTEMS N6

(8080306)

26 March 2013 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 8 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. Substantiate your work with authoritative and easily checkable website links where necessary.
5. Write neatly and legibly.

NOTICE TO CANDIDATES

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

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QUESTION 1

1.1 What is the International Electrotechnical Commission (IEC)? Describe its functions and its worldwide importance. (5)

1.2 Describe why the International Electrotechnical Commission (IEC) is a truly international organisation. (5)

1.3 What relevance does the International Electrotechnical Commission (IEC) have for logic systems in the South African context? (5)

1.4 Write a professionally structured report to meet the requirements of the following scenario:

Your company has recently acquired a metal-processing factory in Eastern Europe. Part of this factory uses operational amplifier controls. Your chief engineer asks you to write a report to explain the advantages of computers and why analogue systems have become outdated.

Your report must be professionally prepared and presented. Use appropriate headings. Separate key points by using indents and line-spaces. Underline and capitalise **KEY WORDS.**

Your report should not exceed one page in the ANSWER BOOK. (5)
[20]

QUESTION 2

2.1 PROGRAMMING INSTRUCTION PROCEDURE

The following instruction set is available:

OP-CODE	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)

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Note the following specification information when writing the program:

- The first instruction location with which the program counter is loaded is: **AAAA (HEXADECIMAL)**
- All mathematical operations done before coding must be shown.
- Case sensitivity: Variables must be lower case
- Case sensitivity: Op-codes and addresses must be UPPER CASE
- You may NOT enlarge the instruction set
- The program must stop processing if, after any mathematical operation, the content of the accumulator exceeds the current value of the variable 'z' which is stored in FIB9.
- 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
	OP-CODE	ADDRESS	

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

$$Y = uu + ut \qquad (10)$$

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2.2 PROGRAMMING INSTRUCTION PROCEDURE:

Given below is a program segment together with an accompanying INSTRUCTION SET and information about pre-loaded addresses. Analyse this given information to answer the questions.

INSTRUCTION LOCATION	INSTRUCTION WORD		DESCRIPTION
	OP-CODE	ADDRESS	
AAAA	LOAD	F1B1	Load r
AAAB	ADDA	F1B1	Add r
AAAC	ADDA	F1B1	Add r
AAAD	ADDA	F1B1	Add r
AAAE	ADDA	F1B1	Add r
AAAF	SUBT	F1B2	Subtract s
AAB0	SUBT	F1B2	Subtract s
AAB1	SUBT	F1B2	Subtract s
AAB2	ADDA	F1B3	Add t
AAB3	ADDA	F1B3	Add t
AAB4	ADDA	F1B3	Add t
AAB5	ADDA	F1B3	Add t
AAB6	STOR	F1B8	Store in y (new value)
AAB7	OUTP		Output
AAB8	HALT		Halt

The following INSTRUCTION SET is available:

OP-CODE	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)

Information about pre-loaded addresses.

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

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The value of 'r' is pre-loaded with the decimal integer value 1 100
The value of 's' is pre-loaded with the decimal integer value 1 000
The value of 't' is pre-loaded with the decimal integer value 900
The value of 'u' is pre-loaded with the decimal integer value 800

The integer values, pre-loaded into the alphabetical variables which follow 'u' continue to decrement by 100 so that 'z' is pre-loaded with decimal 300.

2.2.1 Write in the r ANSWER BOOK (under an appropriate heading) the simplest mathematical form of the equation which this program segment solves. (4)

2.2.2 Write in the ANSWER BOOK (under an appropriate heading) what sort of programming language has been used to write this program segment (Machine Code, Assembler, BASIC, COBOL, C++, Ruby-on-Rails, or other). (4)

2.2.3 Write in your ANSWER BOOK (under an appropriate heading) the value (numerical or otherwise) printed out on completion of this program segment. Show ALL steps in your calculation. (2)
[20]

QUESTION 3

3.1 Draw a complete, fully-labelled block diagram of a STAIRCASE RAMP analogue-to-digital converter. Also draw the staircase voltage waveform. Clearly show where the staircase voltage waveform originates and to which component it is connected. (6)

3.2 Discuss the disadvantage of the staircase ramp analogue-to-digital converter in comparison with the successive-approximation analogue-to-digital converter. Clearly explain what component is changed (and to what it is changed) in the successive-approximation ADC to make it a more effective ADC than the staircase ramp. (6)

3.3 Draw a complete, fully-labelled block diagram of the successive-approximation analogue-to-digital converter. (6)

3.4 Name an OPEN SOURCE operating system. (2)
[20]

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QUESTION 4

4.1 To demonstrate why a glitch can appear in a digital-to-analogue convertor you are asked to do the following: Draw the staircase output waveform of a 4-bit digital to analogue converter. The staircase output detailed on the vertical axis must indicate increasing analogue values from 0 mV to 5 mV. Clearly show the corresponding 4-bit digital values on the horizontal axis. Assume that only ONE glitch occurs between steps three and four because bit switch-on takes longer than bit switch-off. Draw this glitch superimposed on the staircase waveform. Clearly show the shape and direction of the glitch as it appears on an oscilloscope screen. Enter the momentary value which causes the glitch and show between which values this momentary value appears. (6)

4.2 Draw a large, neat, fully-labelled block 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 sensor(s) and actuator(s) necessary to control the level. Show 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. (6)

4.3 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 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. (6)

4.4 A programmer is able to program a PLC (Programmable Logic Controller) using either DIAGRAM mode or MNEMONICS (STATEMENT LIST). Icons gives the programmer the choice of display. Describe the form of circuit diagram which is displayed to represent an 'OR' statement. (2)

[20]

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QUESTION 5

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (5.1–5.10) in the ANSWER BOOK. Give a short explanation to motivate the answer.

5.1 The ASCII acronym represents the words 'Associated Standard Code for Information Interchange'.

5.2 The SCADA acronym stands for 'Supersensory Contact and Data Acquisition'.

5.3 SCADA systems are computer systems which control and monitor machinery and industrial processes.

5.4 SCADA systems help technicians to find faults on a broken machine.

5.5 A SCADA system can prepare a report of how many articles a machine has produced in a month.

5.6 A CPU can be described as the ALU (arithmetic logic unit) on one or a few Integrated circuits.

5.7 The weighted resistor digital-to-analogue converter uses an operational amplifier configured as an integrator.

5.8 The gain of a non-inverting operational amplifier is never less than unity.

5.9 A bus can be described as an interface.

5.10 Stack use during an interrupt is much the same as stack use during a subroutine. (10 × 2) **[20]**

TOTAL: 100

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