higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

STORED PROGRAMME SYSTEMS
NQF LEVEL 4

(10040154)

1 March 2018 (Y-Paper)
13:00–16:00

This question paper consists of 6 pages.

NCV

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. Drawings should be drawn neatly and labelled.
5. Symbols should be drawn to the IEC standards.
6. ALL terminal numbering should be shown.
7. ALL labelling should be shown.
8. Write neatly and legibly.

NCV

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QUESTION 1

1.1 Data acquisition (DAQ) involves gathering information in the form of signals from measurement sources until it reaches the PC-based DAQ system.

Signals are then categorised into two groups, namely analogue signals and digital signals.

Briefly explain THREE primary characteristics of an analogue signal. (3 × 2) (6)

1.2 State FOUR factors that need to be taken into account when selecting a network topology. (4)

1.3 Explain what a *field bus system* is. (2)

1.4 INTERBUS is one of the types of field bus systems that are used at the input/output level.

Consider the following description when communication via INTERBUS is used in 'packet transfer mode' using a GPS (global positioning system):

The GPS acts as a 'logical master' i.e. it reads and writes any data areas in the PLC as if it was a master. In this mode an 'interpreter function block' is required in the PLC. In this mode the GPS uses a fixed input and output area data size of 8 words of the PLC's I/O memory table i.e. IW70 and OW70. The GPS transmits commands (read or write requests) based on its outputs. The PLC's interpreter function block scans this input area and performs the requested action then places the results on the output area.

Analyse the above description and produce a labelled block diagram that will explain it. (8 × 1) (8)

[20]

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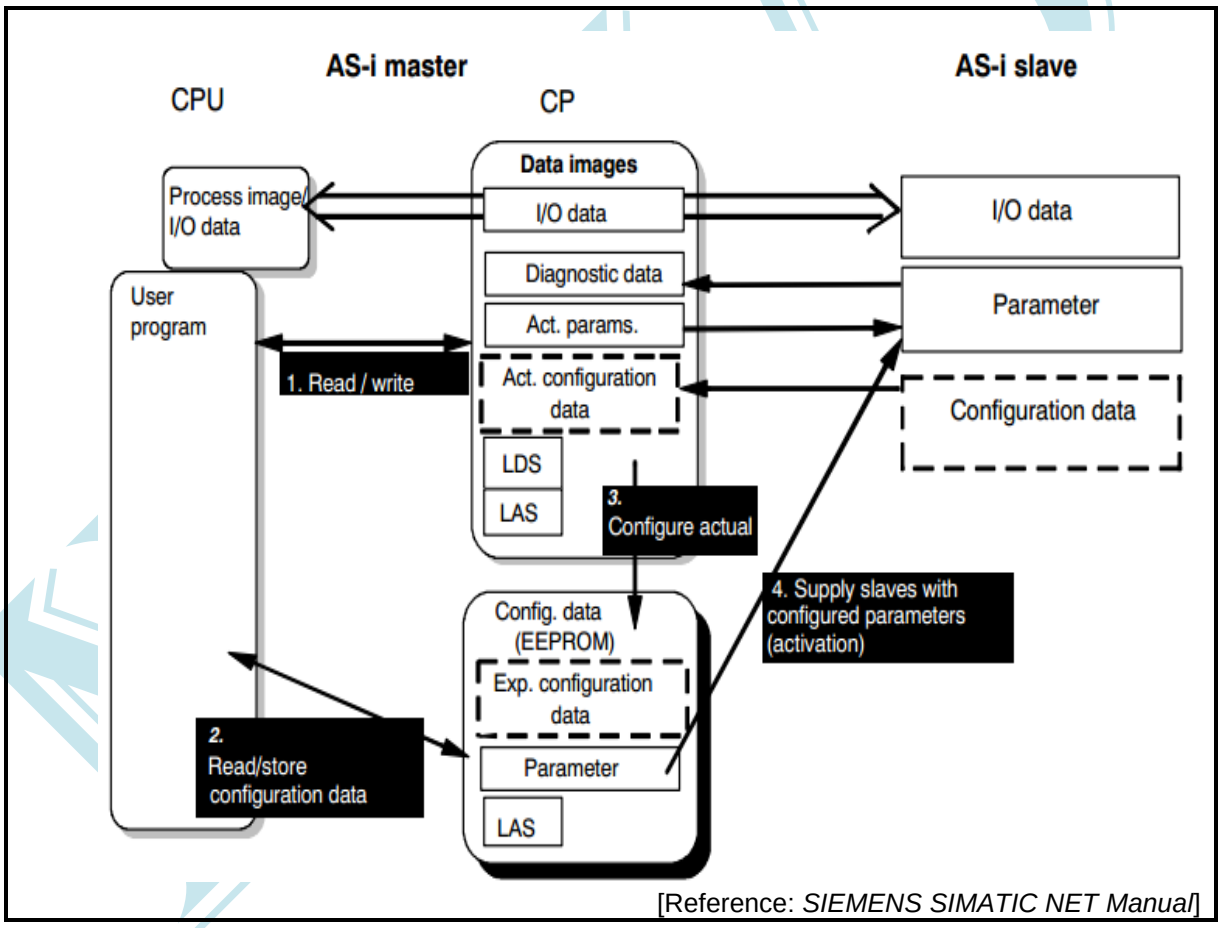
QUESTION 2

2.1 The production lines are made up of various production processes which improve the production flow in the automated industrial operation.

Draw a labelled block diagram of a production process that will represent a flexible, automated production line. (10 × 1) (10)

2.2 An actual/sensor interface (As-I) is a communication system on the lowest factory level in an automation system. As-I operates on the master-slave principle. This means that the As-I master connected to the As-I cable controls the data exchange with the slaves via the interface to the As-I cable.

Analyse FIGURE 1 showing the possible operation and the associated direction of data flow indicated by numbers 1–4 and explain their functions.



[Reference: *SIEMENS SIMATIC NET Manual*]

FIGURE 1

(4 × 2) (8)

2.3 Industrial Ethernet hardware is fairly simple and robust, once the network has been commissioned by a certified installer, the network should be trouble-free.

Name TWO areas that should be checked on a faulty industrial Ethernet system. (2)

[20]

QUESTION 3

3.1 To serve expanding machine and industrial control system development needs, leading automation companies have created a new class of industrial controllers known as programmable automation controllers (PAC).

3.1.1 Briefly explain what a *PAC system* is. (2)

3.1.2 Draw a labelled block diagram that will show how the PAC forms the heart of the communication required for motion, process and sequence control. (6 × 1) (6)

3.2 Centralised control is when the production process is monitored and controlled from a central point.

Draw a labelled block diagram that will show how centralised control can be achieved by making use of a master-slave control of THREE processes via a communication network. (8 × 1) (8)

3.3 In an automated control system there are various points that need to be taken into consideration in the specification of devices being used.

Name any FOUR of these points of consideration. (4)
[20]

QUESTION 4

4.1 Programmable logic controllers and other controllers used in mechatronic systems have built-in software diagnostic tools to help in the identification and repair of any possible malfunctions that may hinder production.

Draw up a checklist of design rules that can help to improve the safety of a system. (8 × 1) (8)

4.2 A revolution in remote diagnostics occurred with the development of a miniature wireless system that could gather information from the safety-related sensors.

Draw a labelled block diagram that will show small, intelligent force convertors that are used in micro-electromechanical systems (MEMs). (10 × 1) (10)

4.3 Engineering technology is not primarily concerned with acquiring information and discovering the laws of nature but rather with creating technical solutions to satisfy human needs.

The mechatronics engineer is always asking 'How can I solve this problem?' This leads to a typical technical approach such as 'black-box thinking'.

Briefly explain what is meant by the *black box approach*. (2)
[20]

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QUESTION 5

5.1 When a new machine or mechatronic system is being prepared for production, or has been delivered and installed by a supplier, it is normal to go through a set of commissioning procedures.

Name SEVEN fundamental steps for the commissioning process. (7)

5.2 To illustrate the use of the SFC (sequence function chart) and how it may be implemented, consider the detail below:

Two double-acting cylinder pistons have to be controlled using a PLC. The operation requirements are as follows:

When a switch which is normally open, is closed momentarily and both cylinder pistons are home, the following sequence should occur:

- Piston A must extend.
- When A has extended, piston B must extend.
- After B has extended for 3 seconds, piston A is then retracted.
- When piston A has retracted, piston B is then retracted.

The sequence does not operate until the switch is closed again, i.e. it operates every time the switch is closed and when piston A is in its home position.

Draw a detailed diagram of the sequence function chart of the detail described above. (13 × 1) (13)

[20]

TOTAL: 100

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