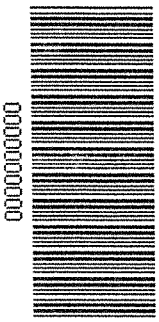

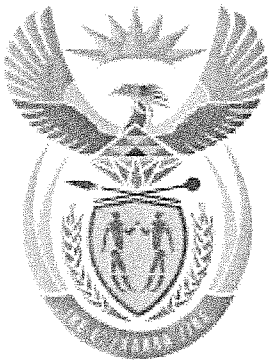

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T410(E)(A1)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

DIGITAL ELECTRONICS N6

(8080376)

1 April 2014 (Y-Paper)
13:00–16:00

This question paper consists of 7 pages.

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. Answer sections of questions in the correct order.
5. Draw diagrams and circuits large and neatly.
6. Label each component on or near the component itself.
7. Do not use coded legends to label components.
8. Write neatly and legibly.

NOTICE TO CANDIDATES

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

QUESTION 1

1.1 Clearly describe the nature of the element which acts as the comparator and controller in an open loop control system. (2)

1.2 Draw a fully-labelled block diagram of an open loop control system to control the rate of flow of a liquid through an adjustable valve. Feedback of the rate of flow is obtained by observing the differential pressure in transparent 'taps' (tubes) which are mounted on either side of an orifice plate. The higher the rate of flow, the greater the differential pressure will be. Give a suitable heading for your block diagram. Label the set point, feedback and action loops. Use a descriptive label to show how set point is obtained. Show how the action loop is activated. Show all signal directions. (8)

1.3 Von Neumann architecture is characterised by a common memory which stores both program instructions and data.

Draw a neat fully labelled block diagram of the control unit of a Von Neumann computer. The micro-instruction unit is a six-bit ring counter. The system is synchronous: Each micro-program has six micro-instructions and 'do-nothing' phases are therefore possible. Show ALL the gates and the interconnections between the micro-instruction unit, program counter, RAM, instruction unit, decoder and arithmetic unit. (10)

[20]

QUESTION 2

2.1 Determine the output of the following program segment. Show every step in your tracking matrix.

Printout values depend on the action of the labelled conditional loop.

```
MATRIX = 5
ITOTAL= 0
646464 ITOTAL = ITOTAL + MATRIX
MATRIX= MATRIX + 4
IF (MATRIX.LT.25) GO TO 646464
PRINT, MATRIX ITOTAL
STOP
END
```

(10)

2.2 A microprocessor is defined as 'a CPU on one or a few chips (integrated circuits)'.

Draw a fully labelled block diagram of an INTEL microprocessor. Name the microprocessor and state the name of the manufacturer. (7)

2.3 What are the advantages for the system designer of using a microcontroller rather than a microprocessor? (3)

[20]

QUESTION 3

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (3.1–3.10) in the ANSWER BOOK. Give a brief explanation to justify the answer.

3.1 Open International Standard IEC 61131-3 is issued by the International Standards Organisation (ISO).

3.2 The stepper motor is an actuator controlled by an analogue signal.

3.3 'Modem' is an acronym for Modern-demodulator.

3.4 The instruction cycle is composed of a 'fetch' routine and an 'increment' routine.

3.5 A flow chart gives a written description in sequential paragraphs of the steps involved in finding the solution to a problem.

3.6 A microprocessor is defined as an ALU (Arithmetic Logic Unit) on one or a few integrated circuits.

3.7 Most actuators are able to receive a digital signal direct from the computer.

3.8 A compiled program runs slower than a translated program.

3.9 UPC (Universal Product Code) is a machine-readable bar code.

3.10 A real-time computer registers inputs as soon as they are made.

(10 × 2) **[20]**

QUESTION 4

A fax machine is transmitting data over telephone lines to another fax machine.

4.1 Draw a neat, fully labelled block diagram to show the functions which take place for the transmitted text to be satisfactorily received. Clearly label the signal transformations taking place at every stage of the transfer of information. Show the direction of information transfer. (5)

4.2 Use a sketch with relevant waveforms and explain the process of FSK ('Frequency Shift Keying') (3)

4.3 4.3.1 Explain the function in the modem in QUESTION 4.1. (2)

4.3.2 Draw a block diagram of a modem:
Show the directions of data transmission and reception.
Show ALL interfacing and signal processing elements and also connections to telephone lines and the fax-machine. (4)

4.4 Explain the synchronous transfer of data between modems. Explain how this method eliminates the need for start and stop bits. (3)

4.5 Briefly explain what is meant by a *real-time computer*. (1)

4.6 Why can the South African Airways Reservation System be described as a real-time system? (1)

4.7 Can the computer which controls a reaction inside a reactor in a chemical plant be described as working in real-time? (1)
[20]

QUESTION 5

5.1 Write in the ANSWER BOOK the text (including spaces and line feeds) which is printed as a result of the following BASIC program. The numeric ASCII values are stored to construct English words. These cannot be changed or translated. Your answer MUST reflect the ASCII values which the program selects for printout.

```
10  REM  Dollar sign addresses ('variables') store ASCII characters.  A
20  REM  string of ASCII characters can be described as "TEXT".
30  REM  Carefully analyse the conditional GOTO statements in this
40  REM  program.  Then write in your answer book the text printed as a
50  REM  result of this program.
60  LET TEXTY01$ = "NEAT PRESENTATION"
70  LET TEXTY02$ = "COUNTS"
80  LET TEXTY03$ = "WHEN YOU WRITE"
90  LET TEXTY04$ = "NATIONAL DIPLOMA EXAMS"
100  LET TEXTY05$ = "MESSY UNPROFESSIONAL WORK"
110  LET TEXTY06$ = "SHOWS"
120  LET TEXTY07$ = "A"
130  LET TEXTY08$ = "DON'T  CARE  ATTITUDE"
140  LET TEXTY09$ = "ENGINEERS AND TECHNICIANS"
150  LET TEXTY10$ = "MUST"
160  LET TEXTY11$ = "CARE"
170  LET TEXTY12$ = "ABOUT"
180  LET TEXTY13$ = "THEIR WORK"
190  LET TEXTY14$ =  "THE LIVES AND SAFETY OF PEOPLE"
200  LET TEXTY15$ = "IN"
210  LET TEXTY16$ = "CARS LIFTS JETS"
220  LET TEXTY17$ = "AND IN"
230  LET TEXTY18$ = "HOSPITAL"
240  LET TEXTY19$ = "AND IN"
250  LET TEXTY20$ = "THE WORKPLACE"
260  LET TEXTY21$ = "ARE"
270  LET TEXTY22$ = "IMPORTANT"
280  LET TEXTY23$ = "LIVES DEPEND ON"
285  LET TEXTY24$ =  "THE WORK"
290  LET TEXTY25$ =  "OF"
```



```
300  LET TEXTY26$ = "TECHNICIANS AND ENGINEERS"
320  LET TEXTY28$ = "WHEN"
330  LET TEXTY29$ = "THEY ARE PLANNING"
340  LET TEXTY30$ = "AND"
350  LET TEXTY31$ = "IMPLEMENTING"
360  LET TEXTY32$ = "HARDWARE AND SOFTWARE"
370  LET TEXTY33$ = "SOLUTIONS"
380  LET TEXTY34$ = "TO MAKE"
390  LET TEXTY35$ = "TRAFFIC LIGHTS"
400  LET TEXTY36$ = "LIFTS"
410  LET TEXTY37$ = "JETS"
420  LET TEXTY38$ = "AND"
430  LET TEXTY39$ = "INTENSIVE CARE UNITS"
440  LET TEXTY40$ = "WORK PROPERLY"
441  LET TEXTY41$ = "  "
442  LET TEXTY42$ = "DEPEND ON"
443  LET TEXTY43$ = "THE NECESSITY TO PLAN AND PRESENT"
444  LET TEXTY44$ = "PROFESSIONAL WORK
445  LET TEXTY45$ = "IN DIPLOMA LEVEL EXAMINATIONS"
450  REM   Note carefully what ASCII has been entered into which
460  REM   SEQUENCER$ variables.  This will decide which of the
470  REM   conditional GOTO's are activated and what text is printed.
480  LET SEQUENCER11$ = "FIRST "
490  LET SEQUENCER11$ = "SECOND "
500  LET SEQUENCER11$ = "THIRD"
510  LET SEQUENCER22$ = "FIRSTLY "
520  LET SEQUENCER22$ = "SECOND"
530  LET SEQUENCER25$ = "THIRD "
540 REM   Now here below are the conditional GOTO's.  They link up to
550  REM   the PRINT statements to select what text is printed and in
560  REM   what order that text is
561  REM   printed.
562  PRINT "BELOW IS THE FINAL PRINT-OUT FOR TODAY'S"
563  PRINT  "PROGRAM:"
564  CLS
565  PRINT "SOMETHING NEW FOR TODAY!"
570  IF SEQUENCER11$ = "FIRSTLY" THEN GOTO 670
580  IF SEQUENCER11$ = "SECONDLY" THEN GOTO 690
590  IF SEQUENCER11$ = "THIRDLY" THEN GOTO 730
600  IF SEQUENCER22$ = "FIRST" THEN GOTO 730
610  IF SEQUENCER22$ = "SECOND" THEN GOTO 750
620  IF SEQUENCER22$ = "THIRD" THEN GOTO 770
630  REM       Here finally, you find the PRINT statements.  These (if and
640  REM       when they are activated by the program above) will do the
650  REM       donkey work of printing out the text which is stored
660  REM       (in ASCII format) in the numbered TEXTY$ variables.
670  PRINT TEXTY01$, TEXTY 41$, TEXTY02$
680  GOTO 800
690  PRINT TEXTY04$, TEXTY 41$, TEXTY21$, TEXTY41$, TEXTY22$
700  GOTO 800
```



```
710 PRINT TEXTY23$, TEXTY 41$, TEXTY26$
720 GOTO 800
730 PRINT TEXTY35$, TEXTY 41$, TEXTY10$, TEXTY41$, TEXTY40$
740 GOTO 800
750 PRINT TEXTY42$, TEXTY 41$, TEXTY44$
760 GOTO 800
770 PRINT TEXTY29$, TEXTY 41$, TEXTY32$
780 GOTO 800
790 PRINT TEXTY33$, TEXTY 41$, TEXTY40$
800 END
```

(10)

5.2 The 11-year solar cycle has periods when solar flares cause ionospheric and other disturbances. These in turn disturb electronic communications.

5.2.1 Give TWO reasons why digital communications are more reliable than analogue communications during periods of intense sunspot activity. (2)

5.2.2 The following encoded data contains Hamming parity check bits. Assume a single error is caused by a cosmic particle emitted during a solar storm. Detect and correct the bit which is in error in the data 111111110. (6)

5.3 Determine the decimal equivalent of the following computer word which is represented in floating point form:

SIGN-BIT	EXPONENT	SIGN-BIT	MANTISSA
O	101	0	110110

(2)
[20]

TOTAL: 100

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MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL-EXAMINATION

DIGITAL ELECTRONICS N6

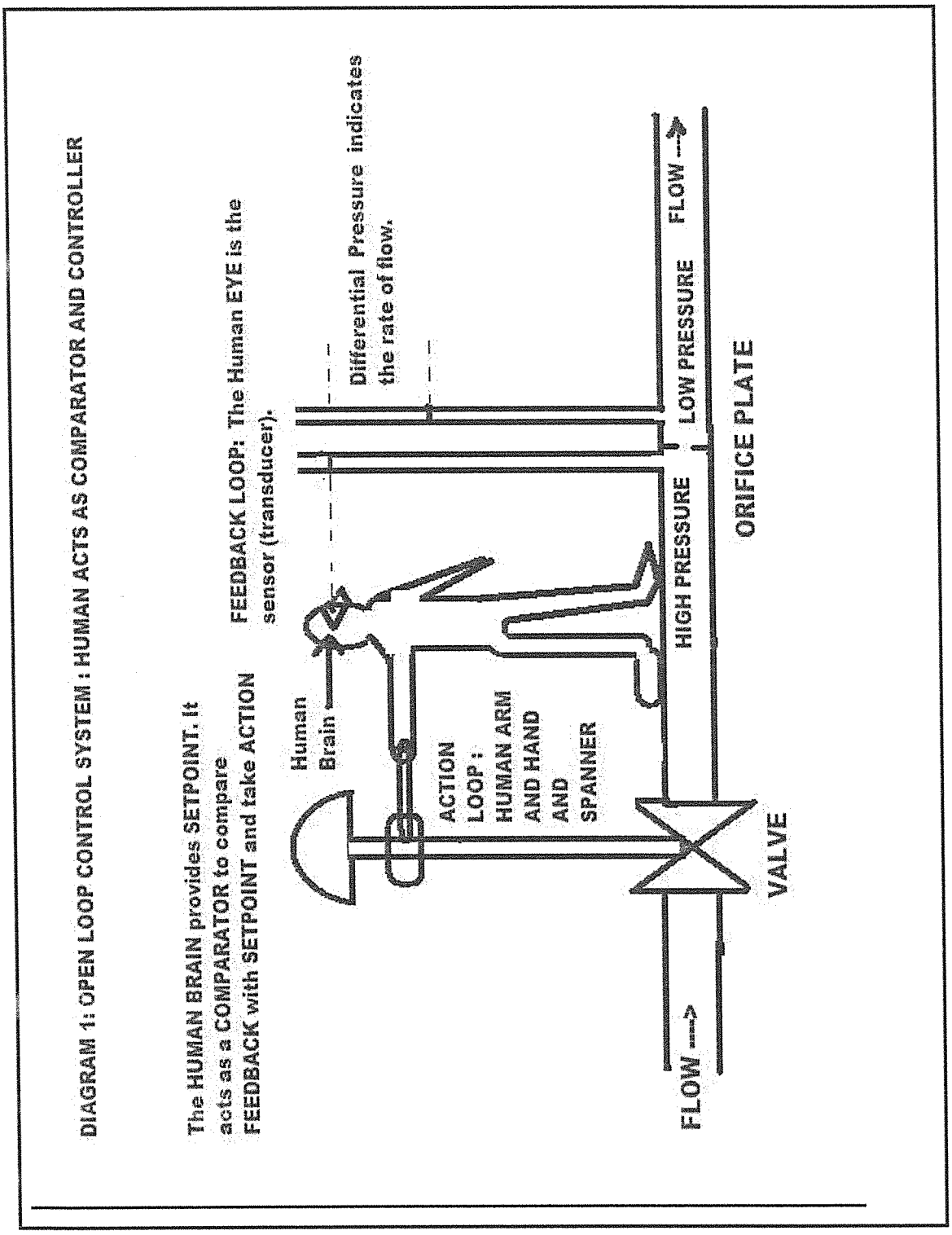
1 APRIL 2014

This marking guideline consists of 9 pages.

QUESTION 1

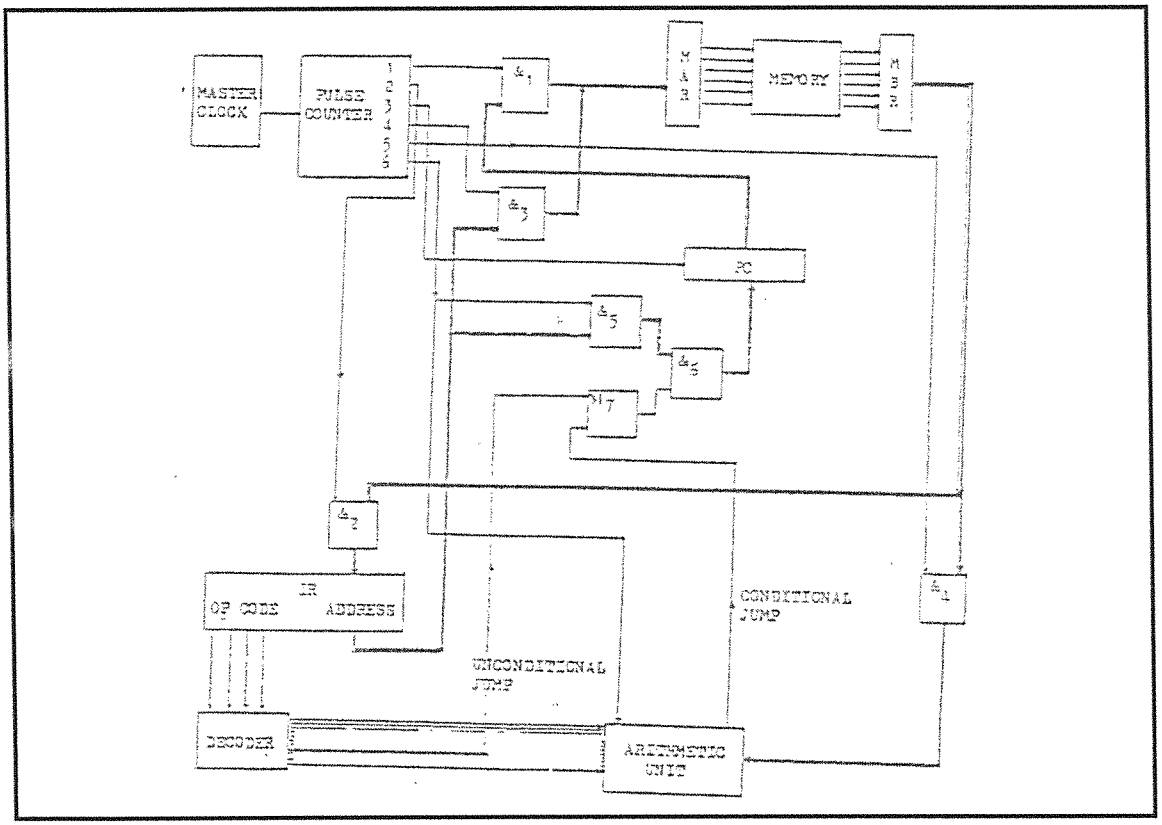
1.1 The element which acts as the comparator and controller in an OPEN LOOP system is a HUMAN BEING (2)

1.2



√ √ √ √ √ √ (8)

1.3 COMPUTER CONTROL UNIT



(10)
[20]

QUESTION 2

2.1

OPERATION NUMBER	PASS NUMBER	VARIABLES/VERANDELIKES	
		MATRIX	TOTAL
1	1	5	
2			0
3			5
4		9	
5	2		14
6		13	
7	3		27
8		17	
9	4		44
10		21	
11	5		65
12		25	
√	√	√	√

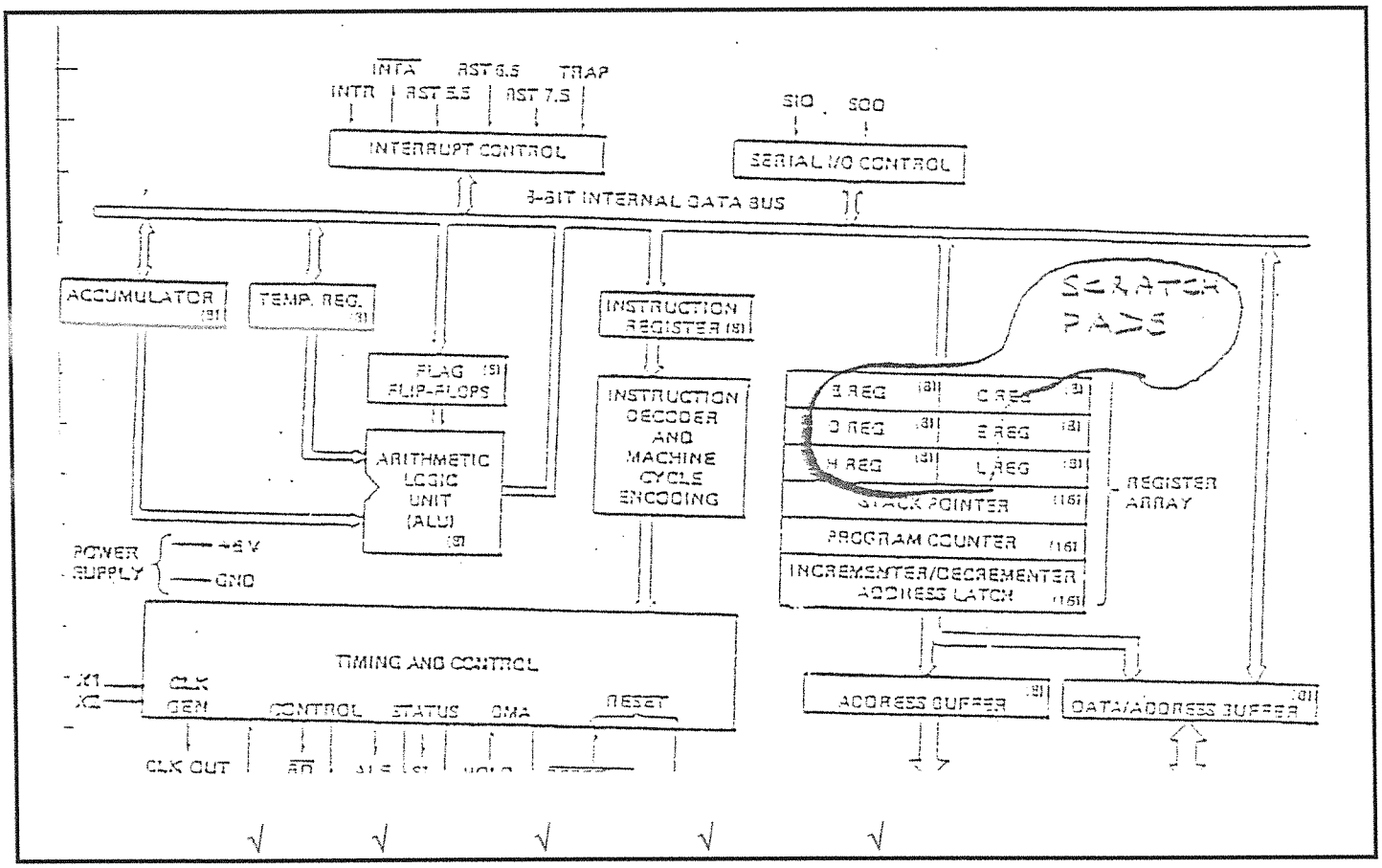
√

OUTPUT
25 65
√ √ √ √ √

(10)

2.2 BLOCK DIAGRAM: MICROPROCESSOR

INTEL 8085A CPU√



√ √ √ √ √

Manufacturer: INTEL CORP√ (7)

2.3
- Programmable A/D and D/A.√
- Configurable Input/Output points.√
- Softwiring instead of hardwiring and also integrated interfacing and support functions.√ (3)

[20]

QUESTION 3

3.1 FALSE√
The standard is promulgated by the International Electrotechnical Commission (IEC) √

3.2 FALSE√
The stepper motor is a digital actuator. √

3.3 FALSE√
Modem is the acronym for Modulator/Demodulator. √

3.4 FALSE√
The instruction cycle is composed of a FETCH and EXECUTE routine. √

3.5 FALSE√
A flowchart is a GRAPHICAL representation using FLOWCHART symbols. √

3.6 ONWAAR√
A microprocessor is a CPU on one or a few chips. (Ref: Penguin dictionary of Electronics.) √

3.7 FALSE√
Most actuators need D/A conversion√

3.8 FALSE√
Compiled programs are EXECUTABLE. They are already compiled into machine code. ('0's and '1's) and so they run fast. √

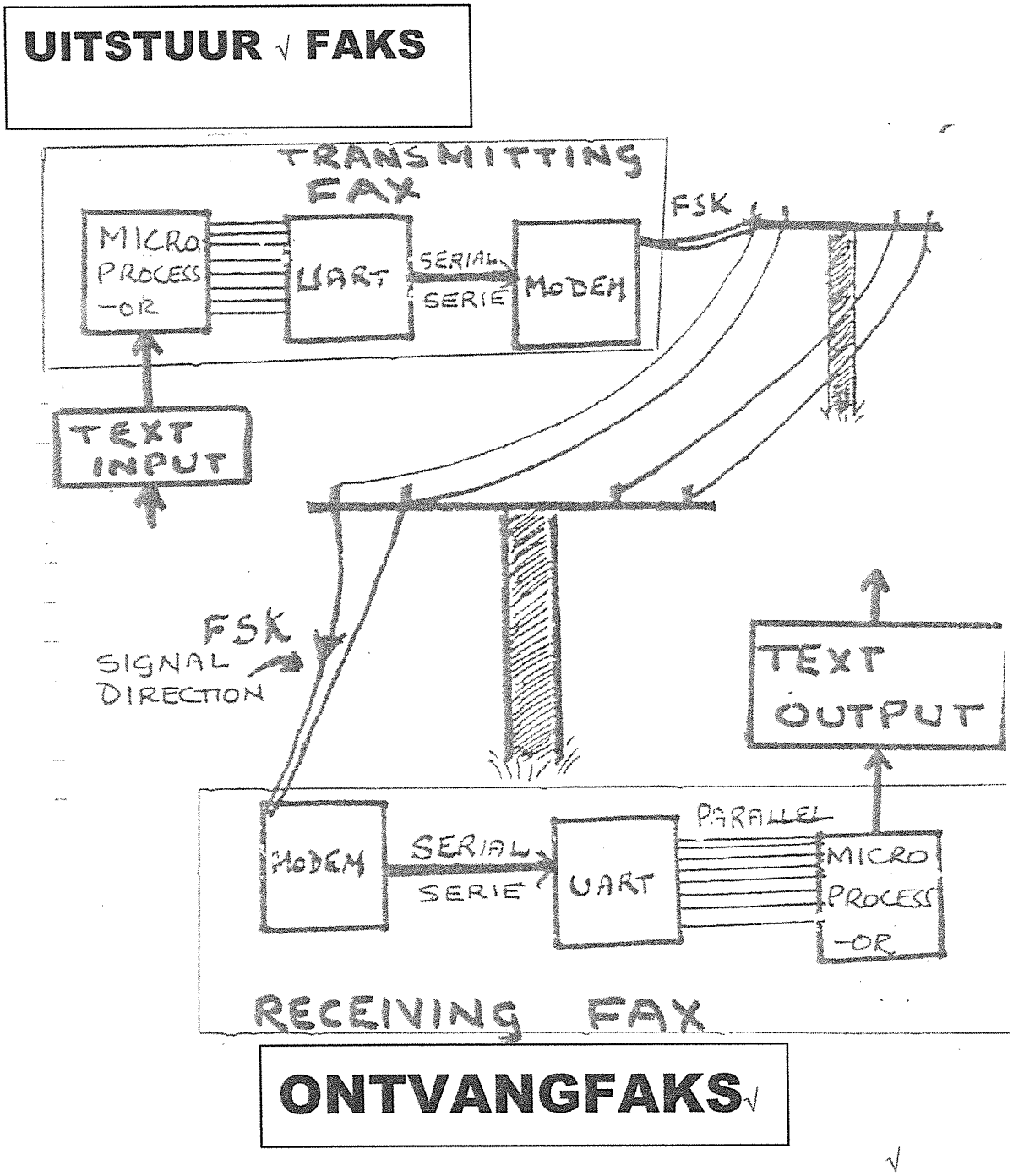
3.9 TRUE
UPC (Universal Product Code) is a machine readable bar-code. This type of bar-code is used by most large South African retailers (like Edgars, Pic 'n Pay, Spar and Shoprite) at their automated till-points. One advantage to the retailers is the automatic computer adjustments of Sales and Stock Levels as each purchase is made. This simplifies book-keeping and stock-taking. √

3.10 TRUE√
A good example of a real time computer is an ATM because you cannot withdraw your maximum withdrawal amount.√

(10 × 2) **[20]**

QUESTION 4

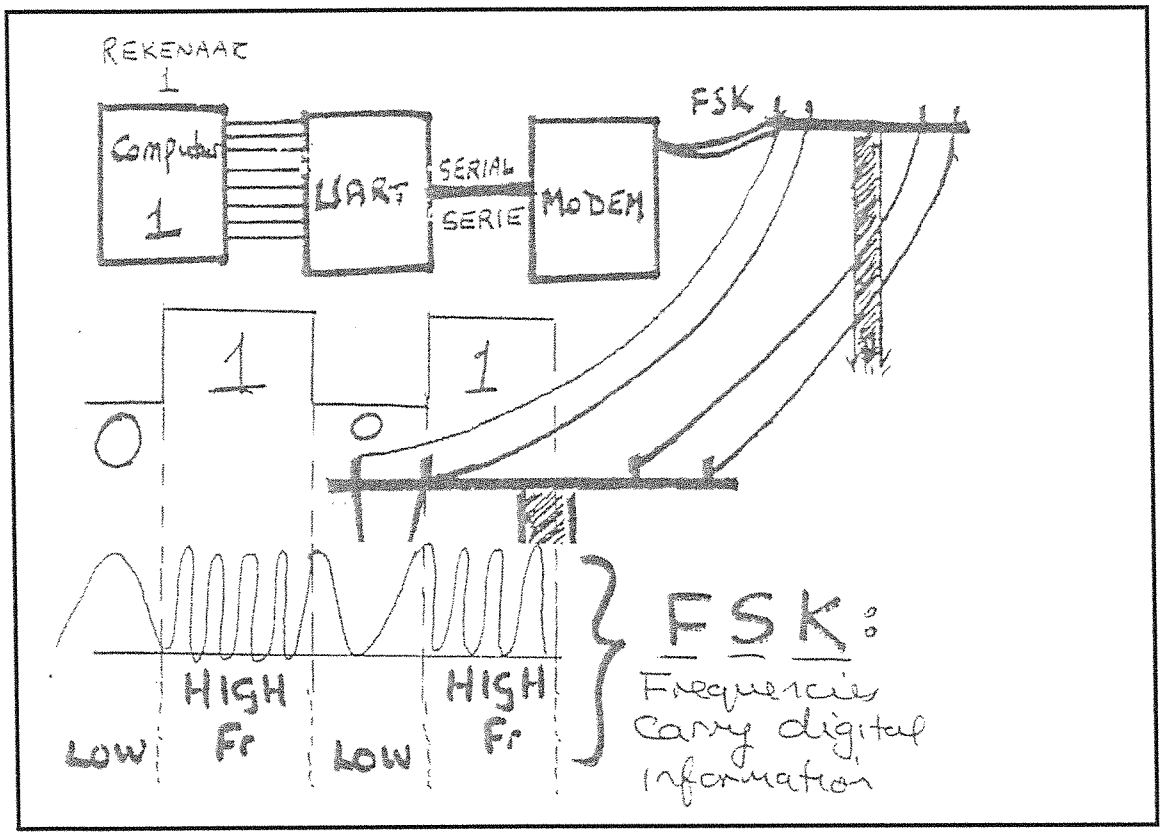
4.1 √ √



√

(5)

4.2 THE PROCESS OF FREQUENCY SHIFT KEYING WITH RELEVANT WAVEFORMS AND EXPLANATION

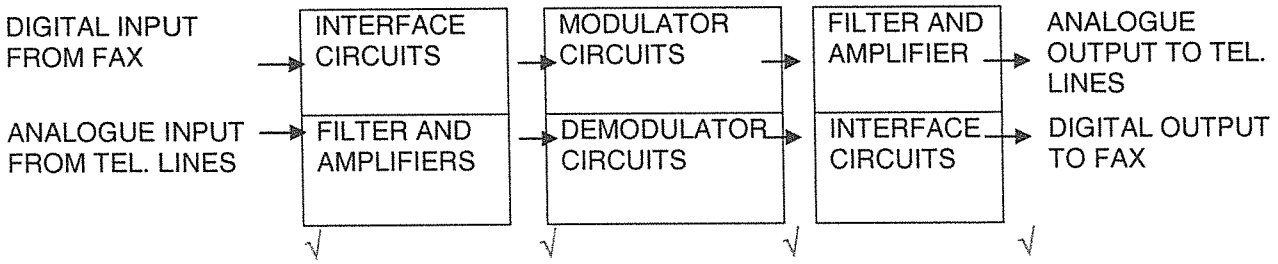


FSK IS A MODULATION PROCESS. A HIGH FREQUENCY TONE MEANS LOGIC LEVEL '1'. A LOW FREQUENCY TONE MEANS LOGIC LEVEL'0'. MODEMS MODULATE THE BINARY DATA DURING TRANSMISSION AND DEMODULATE THE DATA DURING RECEPTION. (3)

4.3 THE FUNCTION OF THE MODEM in the transmitting fax is to convert digital data (the zeros and ones of ASCII) to tones which can be transmitted over telephone lines. This process is called MODULATION. √

THE FUNCTION OF THE RECEIVING MODEM is to convert the tones received into digital data. This is DEMODULATION. This digital data can be converted into ASCII and then alphanumeric text printouts.√ (2)

BLOCK DIAGRAM: MODEM

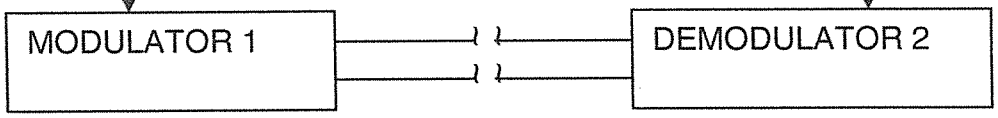


√ √ √ √ (4)

4.4 Synchronous data transfer between modems.

METHOD: HANDSHAKING

√ MODEM CLOCK SYNCHRONISATION



(2) Bit count during transfer

No start and stop bits

Bit counting delimits characters

√ **NOTE:** The above process is accomplished using a two-wire, send/receive system. (3)

4.5 Real-time Computer: reacts to events as they occur. (1)

4.6 SAA Reservation System is 'real-time' because it reacts immediately to book a seat. (1)

4.7 Yes (1)
[20]

QUESTION 5

5.1 SOMETHING NEW FOR TODAY!
DEPEND ON PROFESSIONAL WORK (10)

5.2 REASONS FOR THE RELIABILITY OF DIGITAL COMMUNICATIONS:

- Noise immunity
- Digital code correction systems like Hamming Code. (2)

5.3 **HAMMING CODE --- HAMMINGKODE**

POSITIONS:	1	2	3	4	5	6	7	8	9
	P1	P2	D1	P3	D2	D3	D4	P4	D5
	1	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***0***

P1 CHECKS POSITIONS 1 3 5 7 9
P2 CHECKS POSITIONS 2 3 6 7
P3 CHECKS POSITIONS 4 5 6 7
P4 CHECKS POSITIONS 8 AND 9

Checking the above positions using even parity gives:
P1 EVEN = 0 (LEAST SIGNIFICANT BIT)
P2 EVEN = 0
P3 EVEN = 0
P4 EVEN = 1

POSITION 1000 BINARY = POSITION 8 DECIMAL IS FAULTY.
WE THEREFORE CHANGE THE "1" IN POSITION 8 TO A ZERO AND THE CORRECTED DATE READS:

1 1 1 1 1 1 1 0 0 (6)

5.4 **DECIMAL EQUIVALENT OF FLOATING POINT FORM**

	0	**101**	**0**	**1101100**
MEANING:	MOVE 5 PLACES TO RIGHT		POSITIVE	BINARY

SO: + 11011 BINARY = 16+8+2+1 = DECIMAL + 27 (2)

[20]

TOTAL: 100

