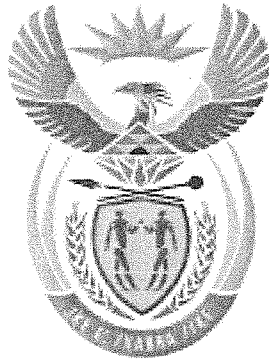
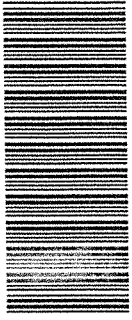


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# higher education & training

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Department:  
Higher Education and Training  
REPUBLIC OF SOUTH AFRICA

T430(E)(A7)T  
APRIL EXAMINATION

NATIONAL CERTIFICATE

DIGITAL ELECTRONICS N6

(8080376)

7 April 2015 (Y-Paper)  
13:00–16:00

This question paper consists of 9 pages.

**DEPARTMENT OF HIGHER EDUCATION AND TRAINING  
REPUBLIC OF SOUTH AFRICA**

**NATIONAL CERTIFICATE  
DIGITAL ELECTRONICS N6**

**TIME: 3 HOURS**

**MARKS: 100**

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**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. Draw diagrams and circuits large and neatly.
  5. Label each component on or near the component itself.
  6. Do not use coded legends to label components.
  7. 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. The signalling systems of digital electronics 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.

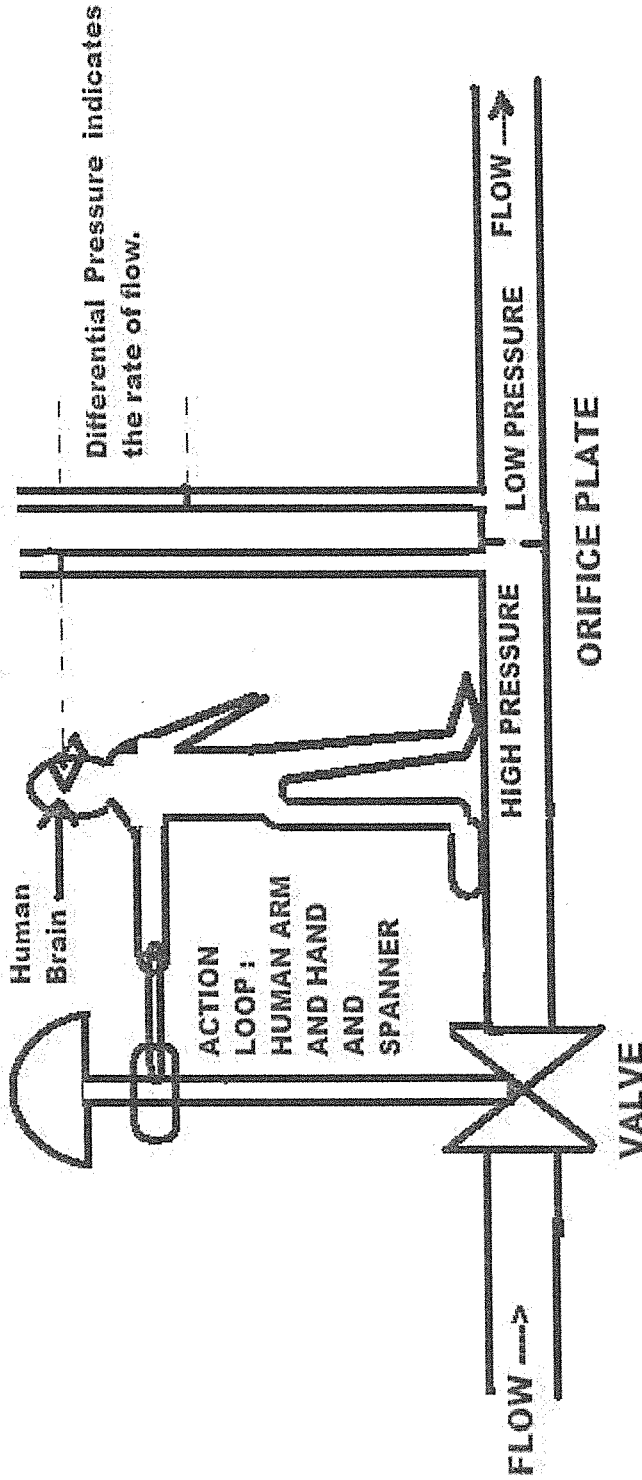
**QUESTION 1**

- 1.1 Give another name for a sunspot. (1)
- 1.2 Explain how sunspots disturb electronic communication. (1)
- 1.3 Give TWO reasons why digital communication is more reliable than analogue communication during periods of intense sunspot activity. (2)
- 1.4 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. (5)
- 1.5 Determine the decimal equivalent of the following computer words which are represented in floating point form:
- | SIGN-BIT | EXPONENT | SIGN-BIT | MANTISSA |
|----------|----------|----------|----------|
| 0        | 101      | 0        | 110110   |
- (1)
- 1.6 Refer to the DIAGRAM on page 4. Take the first design step in order to replace the human operator with an automatic, closed-loop, sense-and-control system. Draw a large, neat, fully-labelled block diagram, showing the basic functions in the new closed-loop control system. Replace the human operator with function and process blocks which will duplicate the functions and processes performed by the human operator. You need NOT show the following:
- Square-root extraction
  - Interfacing of high-power and low-power subsystems
  - Analogue-to-digital conversion (ADC)
  - Digital-to-analogue conversion (DAC)
- Include in your block diagram all functions and processes performed by the human operator in the DIAGRAM on page 4. (10)

**DIAGRAM - OPEN LOOP CONTROL SYSTEM : HUMAN ACTS AS COMPARATOR AND CONTROLLER**

The HUMAN BRAIN provides SETPOINT. It acts as a COMPARATOR to compare FEEDBACK with SETPOINT and take ACTION

FEEDBACK LOOP: The Human EYE is the sensor (transducer).



**QUESTION 2**

2.1 State THREE advantages for the system designer to use a microcontroller rather than a microprocessor. (3)

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 also clearly state the name of the manufacturer. (10)

2.3 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
666444 ITOTAL = ITOTAL + MATRIX
MATRIX = MATRIX + 4
IF (MATRIX.LT.25) GO TO 666444
PRINT, MATRIX ITOTAL
STOP
END
```

(7)  
[20]

**QUESTION 3**

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only '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 The stepping motor is an actuator controlled by an analogue signal.

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

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 (IC's - chips).

3.7 Most actuators are able to receive a digital signal directly 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**

- 4.1 Briefly explain what is meant by a *real-time computer*. (1)
- 4.2 Why can the South African Airways reservation system be described as a real-time system? (1)
- 4.3 Can the computer which controls a reaction inside a reactor in a chemical plant be described as working in real-time? Answer only YES or NO. (1)
- 4.4 Draw a neat, fully labelled block diagram to show the functions which take place in fax-to-fax transmission, so that the transmitted text is satisfactorily received. Clearly label the signal transformations taking place at every stage of the transfer of information. Show the direction of information transfer. (5)
- 4.5 Use a sketch with relevant waveforms and explain the process of FSK ('frequency shift keying'). (3)
- 4.6 Explain the function in the modem in QUESTION 4.5. Draw a block diagram of a modem. Show the directions of data transmission and reception. (6)
- Show ALL interfacing and signal processing elements and also connections to telephone lines and a fax machine. (6)
- 4.7 Explain the synchronous transfer of data between modems. Explain how this method eliminates the need for start and stop bits. (3)
- [20]

**QUESTION 5**

- 5.1 Write in your 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. 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 PRINTOUT 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 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]

**TOTAL:****100**



# higher education & training

Department:  
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**REPUBLIC OF SOUTH AFRICA**

## **MARKING GUIDELINE**

**NATIONAL CERTIFICATE  
APRIL EXAMINATION  
DIGITAL ELECTRONICS N6**

**7 APRIL 2015**

**This marking guideline consists of 8 pages.**

**QUESTION 1**

- 1.1 A sunspot is also called by the more descriptive name of solar flare. (1)
- 1.2 Sunspots are solar flares. These are masses of charged particles. These charged particles are attracted by the earth's magnetic field. They disturb satellite transmissions and reception and the ionosphere. A charged particle can change a digital zero to a digital '1'. (1)
- 1.3
- Noise immunity
  - Digital code correction systems like the Hamming code
- (2)

1.4 **HAMMING CODE**

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

- 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.  
 The '1' in position 8 is therefore changed to a zero and the corrected date reads:

**1 1 1 1 1 1 1 0 0** (5)

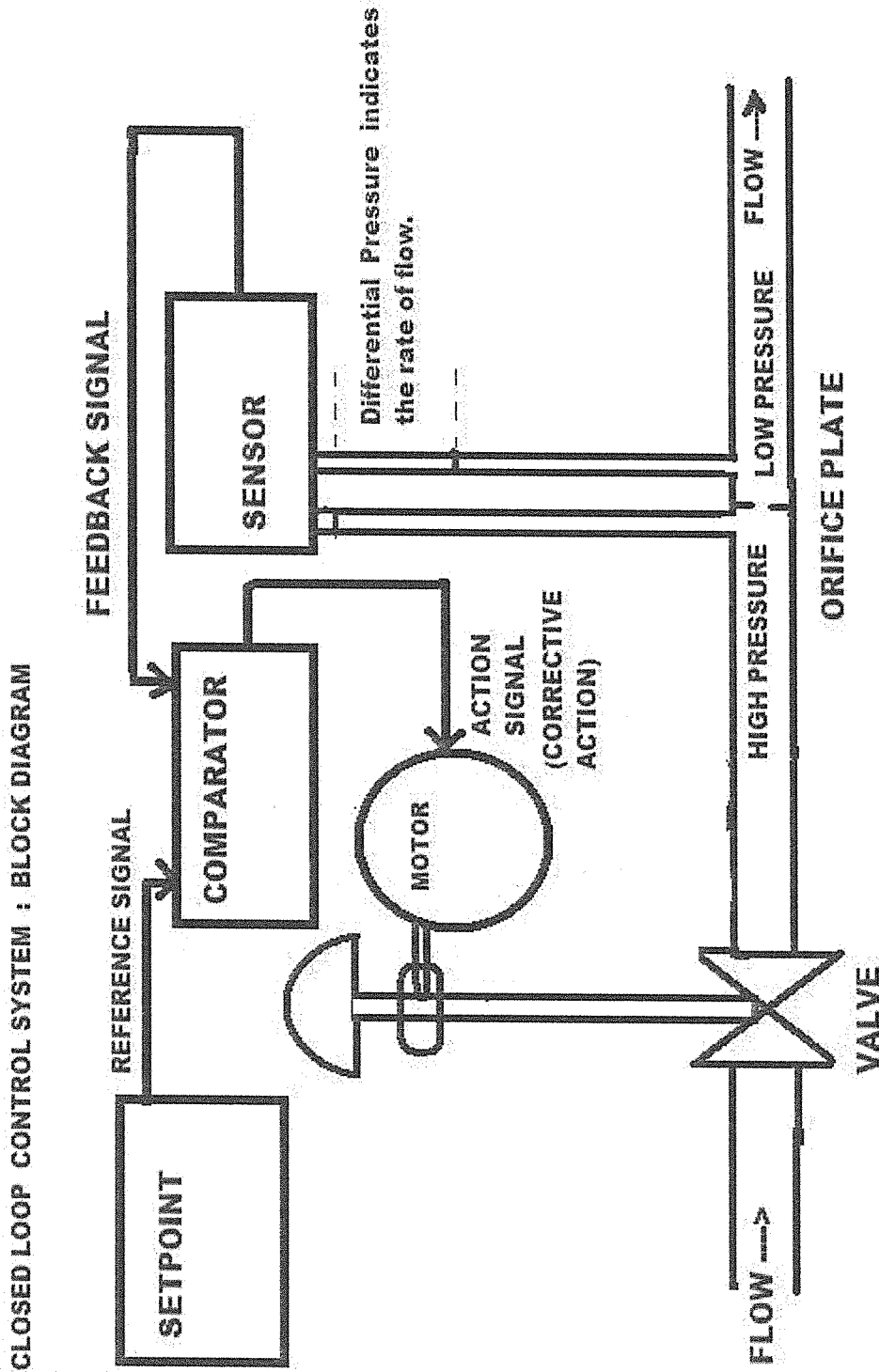
- 1.5 The decimal equivalent of floating-point form:

**0            101                            0            1101100**

**MEANING:**    MOVE 5 PLACES TO RIGHT            POSITIVE    BINARY

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

1.6



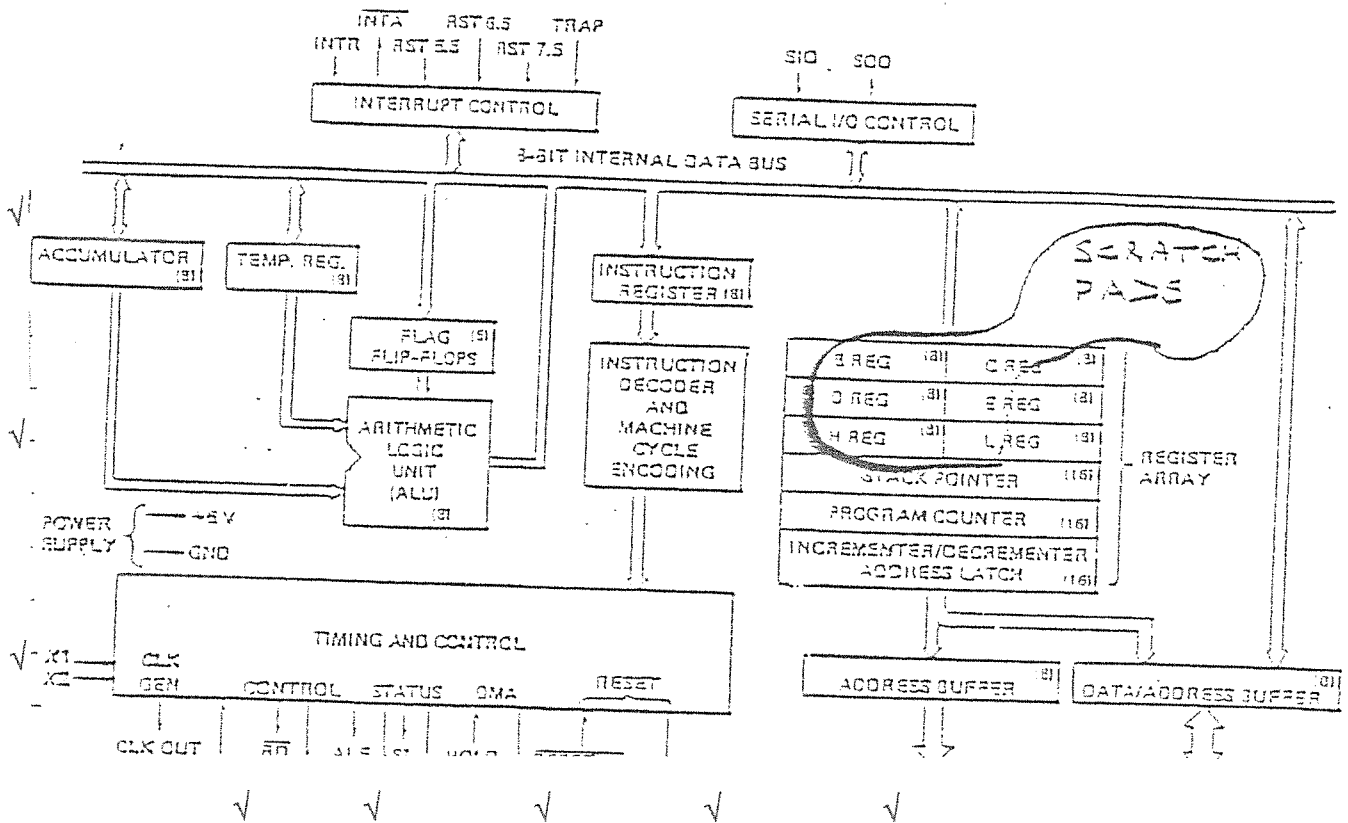
✓  
✓  
✓  
✓  
✓  
✓  
✓  
✓

(10)  
[20]

QUESTION 2

- 2.1
    - Programmable A/D and D/A ✓
    - Configurable Input/output points ✓
    - Softwiring instead of hardwiring and also integrated interfacing and support functions ✓
- (3)

2.2 BLOCK DIAGRAM: MICROPROCESSOR  
INTEL 8085A CPU ✓



Manufacturer: INTEL CORP ✓

(10)

2.3

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

√

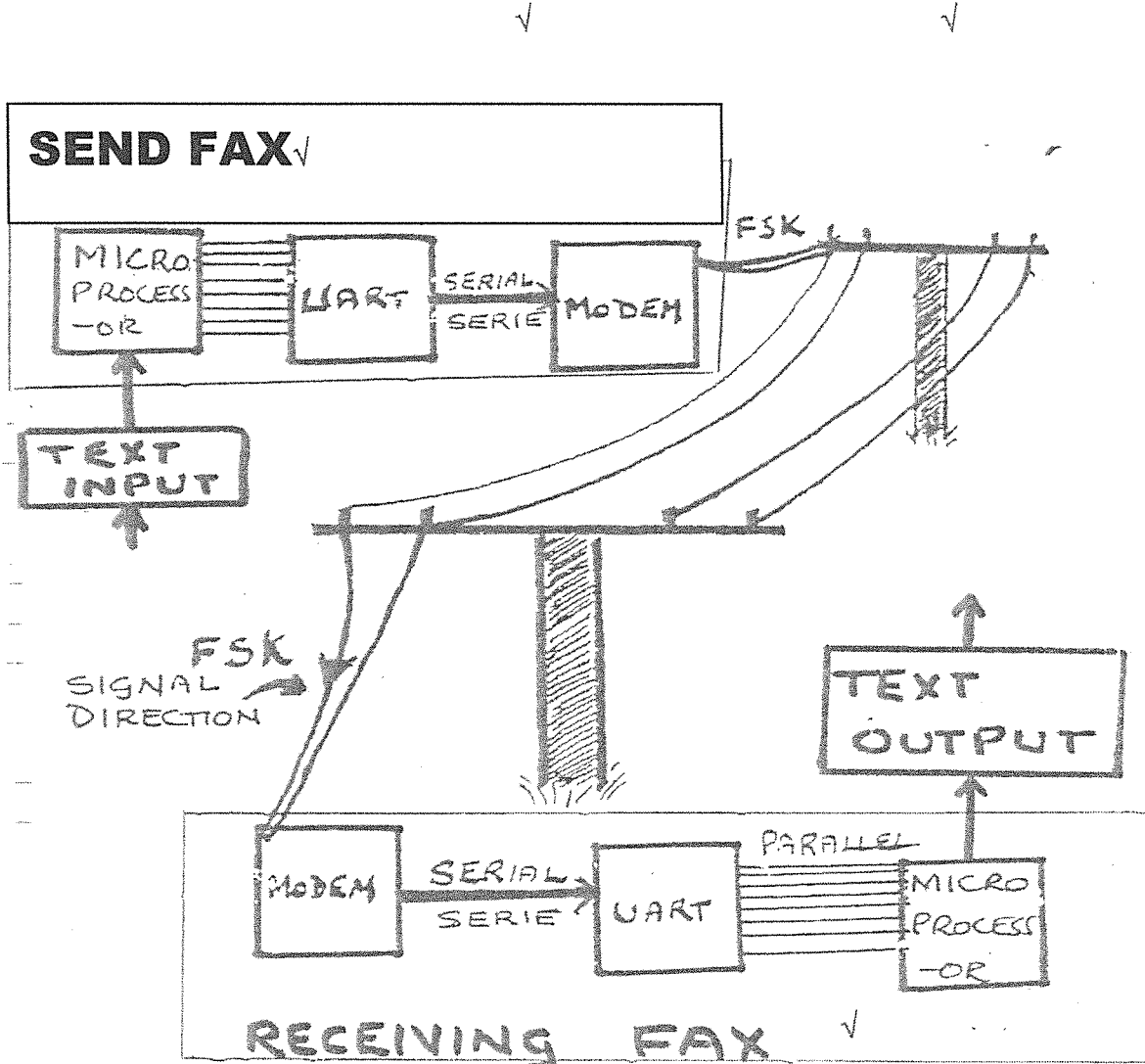
√

(7)  
[20]**QUESTION 3**

- 3.1 False – The stepping motor is a DIGITAL actuator.
- 3.2 False – The standard is promulgated by the INTERNATIONAL ELECTRO-TECHNICAL COMMISSION (IEC).
- 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 False – 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 (such as Edgars, Pick n Pay, Spar, etc.) at their automated till points.
- 3.10 True – A good example is an ATM, because you cannot withdraw more than your maximum withdrawal limit.

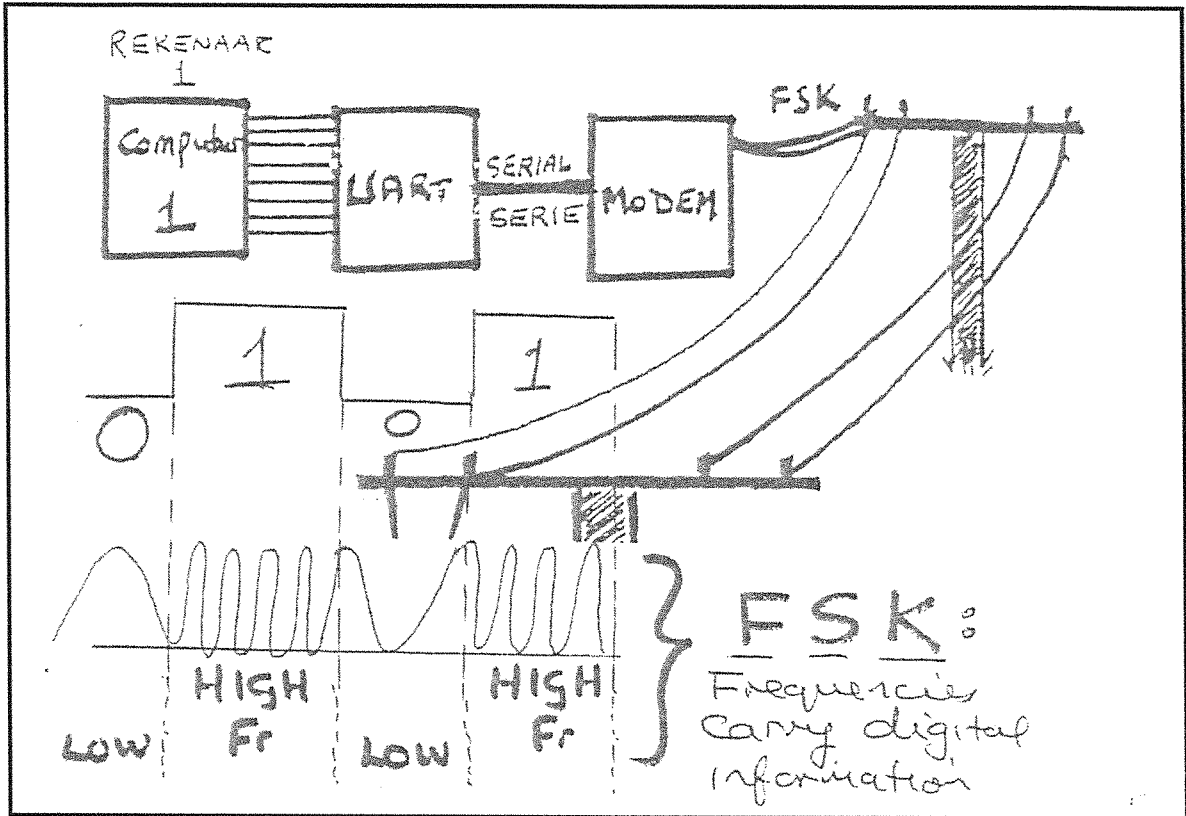
QUESTION 4

- 4.1 Real-time computer: Reacts to events as they occur. (1)
- 4.2 SAA reservation system is 'real-time' because it reacts immediately to book a seat. (1)
- 4.3 Yes (1)
- 4.4 FAX TRANSMISSION AND RECEPTION: (1)



(5)

4.5 The process of frequency shift keying with relevant waveforms and explanation:



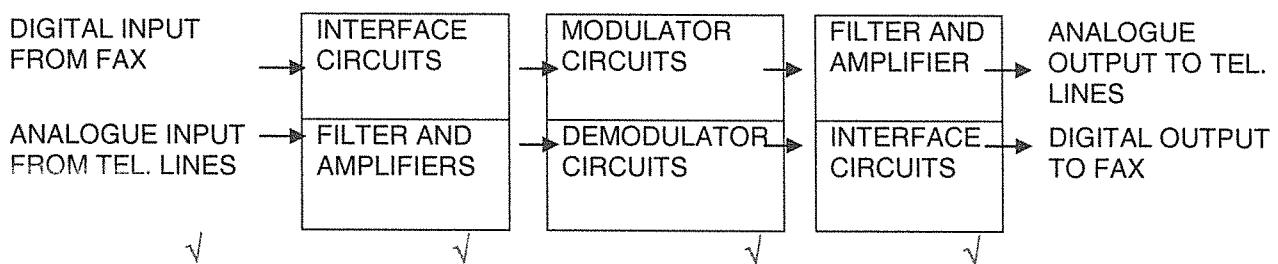
FSK is a modulation process. A high frequency tone means logic level '1'. A low frequency tone means logic level '0'. Modems modulate the binary data during transmission and demodulate the data during reception.

(3)

4.6 The function of the modem in the transmitting fax is to convert digital data (the zeros and ones of ASCII) to frequencies which can be transmitted over telephone lines. This process is called modulation. ✓

The function of the receiving modem is to convert the frequencies received into digital data. This is demodulation. This digital data can be converted into ASCII and then alphanumeric text printouts. ✓

**BLOCK DIAGRAM - MODEM:**



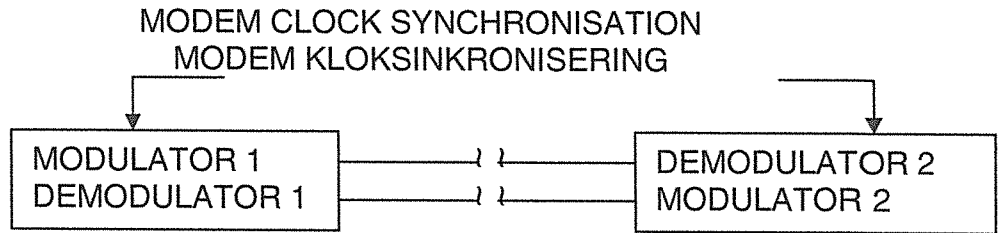
(6)



4.7 Synchronous data transfer between modems:

METHOD: HANDSHAKING

✓



Bit count during transfer  
No start and stop bits  
Bit counting delimits ✓

**NOTE:** The above process is accomplished using a two-wire, send/receive system. ✓

(3)  
[20]

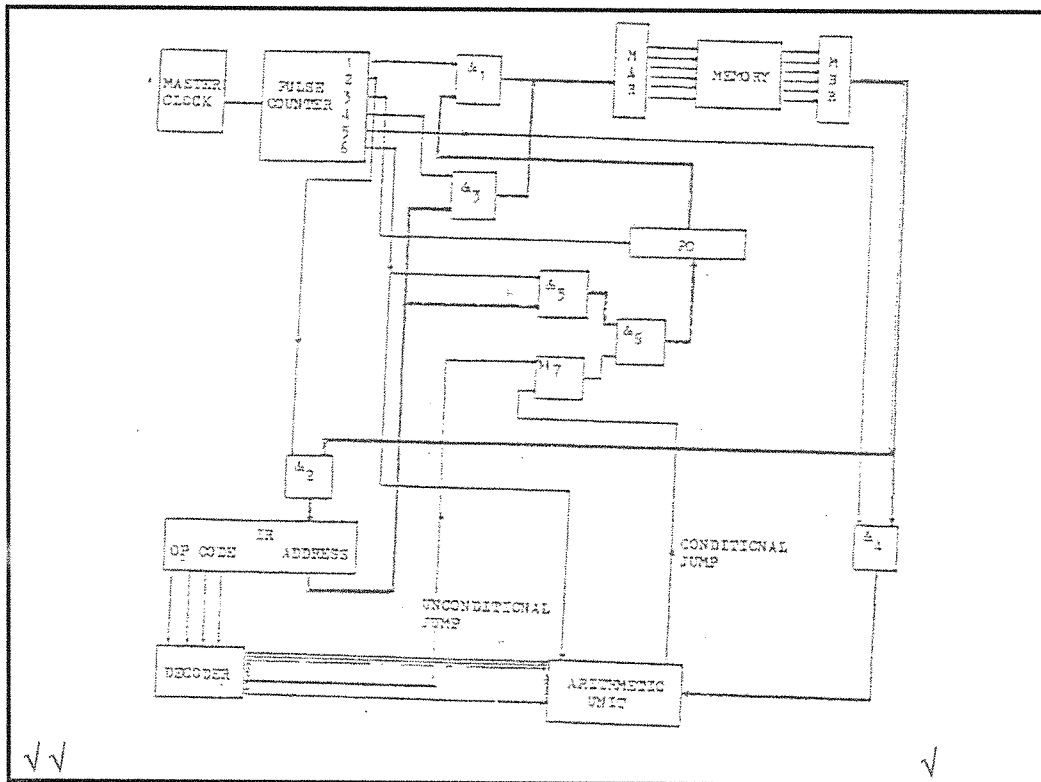
**QUESTION 5**

5.1 SOMETHING NEW FOR TODAY!  
DEPEND ON PROFESSIONAL WORK

(10)

5.2 COMPUTER CONTROL UNIT ✓

✓  
✓  
✓



✓

✓

✓✓

✓

(10)  
[20]

**TOTAL: 100**