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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T460(E)(N21)T
NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

DIGITAL ELECTRONICS N6

(8080376)

21 November 2013 (X-Paper)
09:00–12:00

This question paper consists of 8 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. Write neatly and legibly.

NOTICE TO CANDIDATES

The lives and safety of people depends 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

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (1.1–1.10) in the ANSWER BOOK. Give a brief explanation to justify the answer.

1.1 The International Technical Commission (IEC) sets Open International Standards so that millions of electrical and electronic devices all over the world can fit together and work safely.

1.2 The Open International Standard IEC 61131-3 sets standards for Programmable Logic Controllers (PLC's)

1.3 A stack in a computer holds the address of the next instruction to be executed by the control unit.

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

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

1.6 The instruction cycle is composed of a 'FETCH' routine and an 'INCREMENT' routine.

1.7 ASCII stands for Associated Standard Code for Information Interchange

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

1.9 When a PLC (Programmable Logic Controller) is toggled so that the program displayed as a DIAGRAM is now displayed in STATEMENT LIST, a parallel network is displayed as 'OR'.

1.10 When a PLC (Programmable Logic Controller) is toggled so that the program displayed as a DIAGRAM is now displayed in STATEMENT LIST, a series network is displayed as 'AND'.

(10 × 2) [20]

QUESTION 2

2.1 Write a program segment in BASIC to PRINT every integer from 1 to 100. (5)

2.2 Draw a flowchart for the following problem:

Input THREE integers A, B and C. Add A and B. If the sum is greater than C, then decrement B until the sum is equal to C. If the sum is smaller than C, increment A with one until the sum equals C. If A + B = C, then A and B and C must be printed. Simultaneous parallel processing is NOT possible. Show delimiters. (7)

2.3 PROGRAMMING: INSTRUCTION PROCEDURE: MACHINE CODE.

The following instruction set is available:

OP-CODE	DESCRIPTION
000	Load accumulator
001	Add
010	Subtract
011	Store in memory
100	Output routine
101	Halt

The first instruction location with which the program counter is loaded is: 0000. The operands A, B, C and D are already stored in consecutive addresses. A is stored in address 1011, B is stored in address 1100, et cetera. 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 Y if:

Y = 2(A – B – C).

You may NOT enlarge the instruction set.

The correct delimiter must be used after delivering the output so that memory use is limited to program lines. (8)

[20]

QUESTION 3

Von Neumann architecture is characterised by a common memory which holds BOTH program instructions and data. The sequence of computer operations is controlled by the control unit which accesses the RAM to obtain both instructions and operands.

3.1 Draw a neat, fully labelled block diagram of the control unit of a Von Neumann digital 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 interconnections and gates which link PC MAR RAM MBR IR decoder and ALU. (10)

3.2 Each micro-instruction in the control unit of QUESTION 3.1 permits a transfer of data within the control unit. These transfers are grouped into a FETCH routine and an EXECUTE routine.

Use block diagrams and descriptions to show what transfer of BINARY data occurs for each of the SIX micro-instructions when the following program line is processed:

INSTRUCTION LOCATION	INSTRUCTION WORD		DESCRIPTION
	OP-CODE	ADDRESS	
1011	0111	0000	Add the contents of address 0000 to what is in the accumulator. Address 0000 contains the operand 11110000.

Clearly separate each micro-instruction from the next. Clearly show how the phases (micro-instructions) are grouped into routines. (8)

3.3 Indicate whether the last micro-instruction in QUESTION 3.2 is a 'do-nothing phase' or not. Give a reason to support your answer. (2)
[20]

QUESTION 4

System response and cycle times are important considerations in process control and data communication systems. A technician must be able to facilitate the access of relevant text and other information on the INTERNET and Local Area Networks (LAN's)

4.1 Draw a neat, fully labelled block diagram indicating the elements for interfacing a subscriber's computer with an Internet Service Provider. Telephone lines are used for data communication between the TWO systems. (5)

4.2 Explain the function in the modem in QUESTION 4.1. Draw a block diagram of a modem. Show the directions of data transmission and reception. Show ALL interfacing and signal processing elements, including filters and amplifiers. (5)

4.3 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 has selected for printout.

```
10  REM  Dollar sign addresses ('variables') store ASCII characters.
20  REM  A 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 GO TO's are activated and what text is printed.
480  LET SEQUENCER11$ = "FIRST"
490  LET SEQUENCER11$ = "SECOND"
500  LET SEQUENCER11$ = "THIRD"
510  LET SEQUENCER22$ = "FIRST"
520  LET SEQUENCER22$ = "SECOND"
530  LET SEQUENCER22$ = "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 printed.  First print the heading for your
561  REM output.
562  PRINT "BELOW IS THE FINAL PRINT-OUT FOR TODAY'S"
563  PRINT "PROGRAM:"
564  PRINT
565  PRINT
570  IF SEQUENCER11$ = "FIRST" THEN GOTO 670
580  IF SEQUENCER11$ = "SECOND" THEN GOTO 690
590  IF SEQUENCER11$ = "THIRD" THEN GOTO 710
600  IF SEQUENCER22$ = "TENTH" THEN GOTO 730
610  IF SEQUENCER22$ = "ELEVENTH" THEN GOTO 750
620  IF SEQUENCER22$ = "TWELFTH" 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)
[20]

QUESTION 5

5.1 Cheesemaking today is a scientific computer-controlled process. During the process of cheesemaking a vat of curd must be kept at the precise temperature of 31 °C while whey is drained from the vat. The temperature is monitored by a thermistor circuit. Temperature is controlled by TWO butterfly valves which control the flow of hot and cold water through the pipes coiled around the vat.

Draw a fully labelled block diagram of a digital process control system suitable for monitoring and controlling the temperature of the curd in the vat.

ALL interfacing and peripheral equipment must be shown. Show signal directions.

(10)

5.2 A microprocessor is defined as 'a CPU on one or a few chips (integrated circuits)'. Draw a fully labelled block diagram of a single-chip microprocessor. Write the name of the microprocessor as well as the name of the manufacturer.

(7)

5.3 What are the advantages for the system designer of using a *microcontroller* rather than a *microprocessor*?

(3)
[20]

TOTAL: 100

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MARKING GUIDELINE

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QUESTION 1

1.1 TRUE
South Africa complies with these International Standards to run our own industries and to export to the world.

1.2 TRUE
The IEC 61131-3 has resulted in a remarkable conformity in PLC software. If you know how to program one make of PLC it is very easy to learn how to program the PLC of another manufacturer.

1.3 FALSE
The description fits that of a PC (program counter).

1.4 FALSE
The stepper motor is a digital actuator

1.5 FALSE
The word/name modem is the acronym for Modulator/Demodulator.

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

1.7 FALSE
ASCII stands for American Standard Code for Information Interchange.

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

1.9 TRUE
Claude Shannon, who is known as the 'Father of Information Technology' discovered this basic relationship in the 1930's.

1.10 TRUE
Claude Shannon showed this relationship to be true in his ten page doctoral thesis for the Massachusetts Institute of Technology in the late 1930's.

(10 × 2) **[20]**

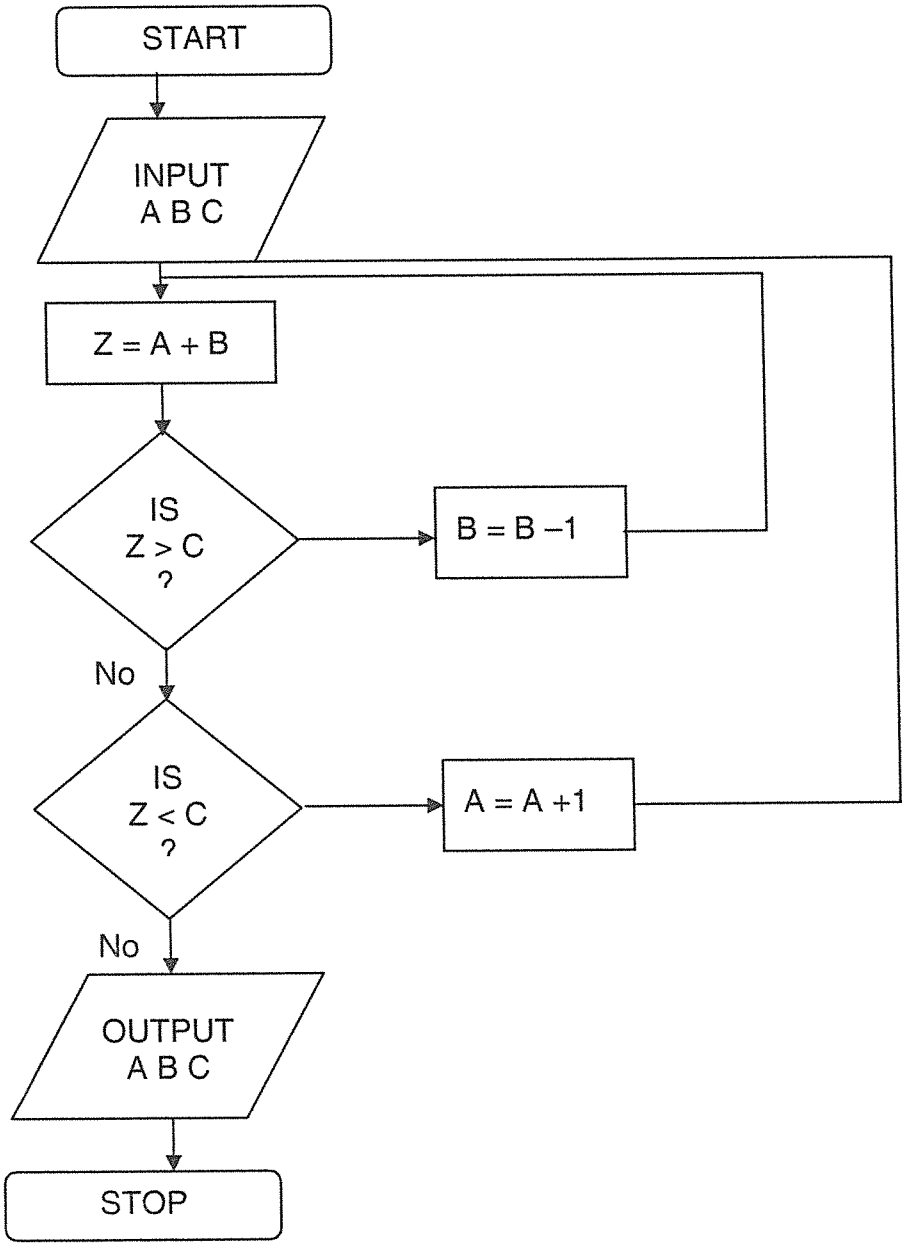
QUESTION 2

2.1 BASIC PROGRAM SEGMENT TO PRINT ALL INTEGERS FROM 1 TO 100

```
2010    LET     INTEGER = 1
2020    PRINT   INTEGER
2030    LET     INTEGER = INTEGER + 1
2040    IF      INTEGER > 100 THEN GOTO 2060
2050    GOTO    2020
2060    STOP
```

(5)

2.2 FLOWCHART:



(7)

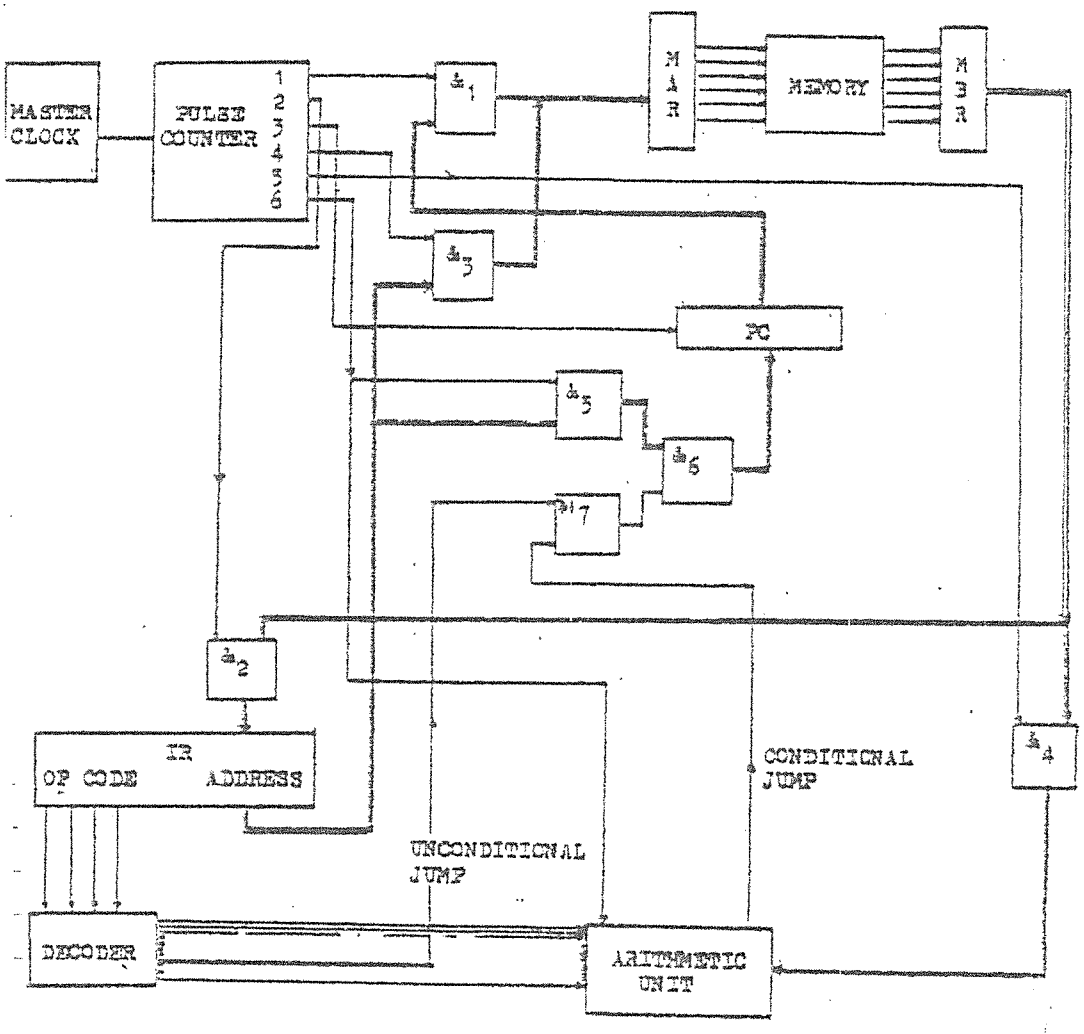
2.3

INSTRUCTION LOCATION	INSTRUCTION WORD		DESCRIPTION
	OP-CODE	ADDRESS	
0000	000	1011	Load A
0001	001	1011	Add A
0010	010	1100	Subtract B
0011	010	1100	Subtract B
0100	010	1101	Subtract C
0101	010	1101	Subtract C
0110	011	1111	Store
0111	100		Output Y
1000	101		Halt

(8)
[20]

QUESTION 3

3.1 **CONTROL UNIT:**

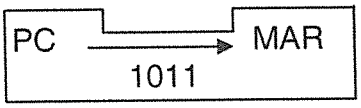


(10)

3.2 FETCH ROUTINE

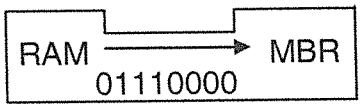
First Micro-instruction: Pulse 1

PC Contents → MAR



Programteller Memory Address Register

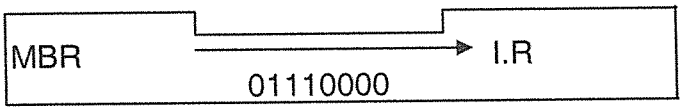
INSTRUCTION [OP-CODE PLUS OPERAND ADDRESS] → MBR



✓

Second Micro-instruction: Pulse 2

INSTRUCTION [OP-CODE PLUS THE OPERAND ADDR.] → = INSTRUCTION REGISTER



INSTRUKSIE REGISTER

✓

Third Micro-instruction: Pulse 3 ✓

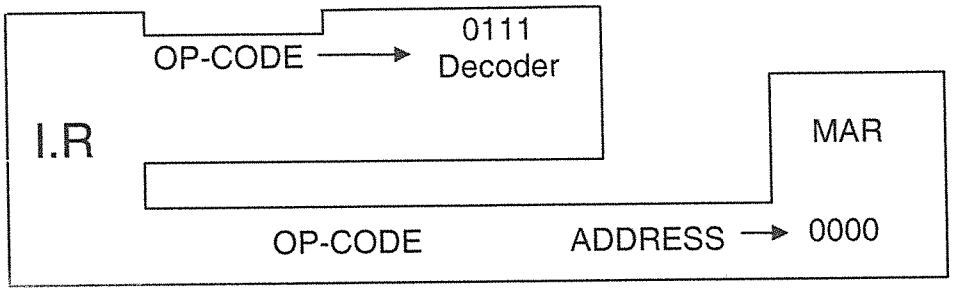
Program counter incremented:

PC = PC + 1
1011 + 1 PC

EXECUTE ROUTINE

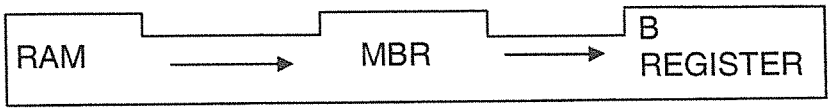
Fourth Micro-instruction: Pulse 4

Instruction-word is SPLIT:



Fifth Micro-instruction: Pulse 5

THE OPERAND (11110000) GOES TO THE ---- B-REGISTER.



11110000 11110000

Sixth Micro-instruction: Pulse 6

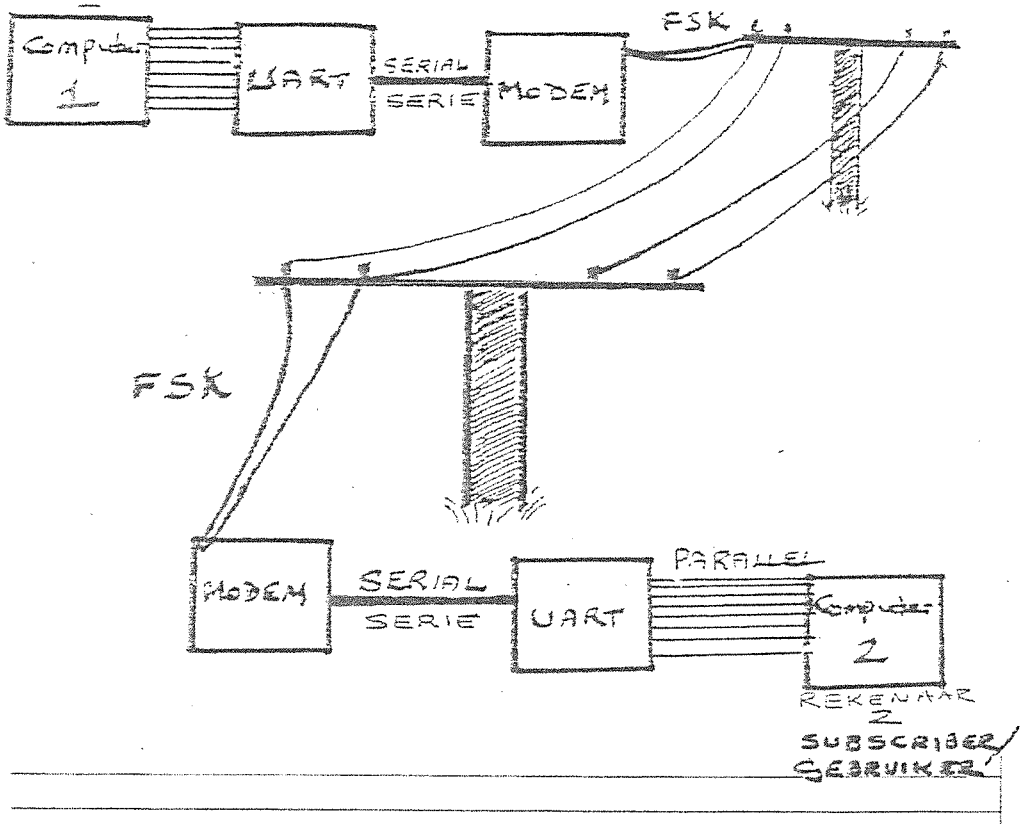
A.L.U/A.L.E. : (A⟵ A + B) (8)

3.3 6th Micro-instruction:

The arithmetic operation is: ADD
∴ Not a 'do-nothing' phase. It's a DO-SOMETHING and the something is ADD. (2)
[20]

QUESTION 4

4.1 **INTERFACING WITH: INTERNET**



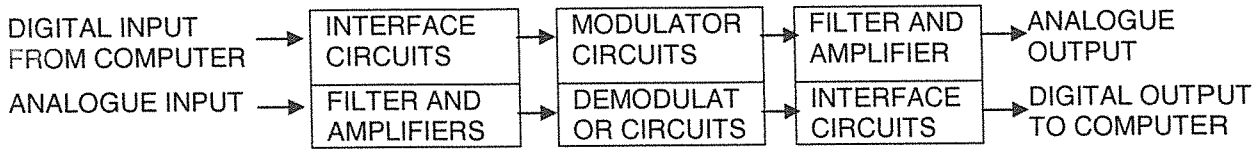
(5)

4.2 Function of a MODEM

MODEM: Acronym for MoDulator/DeModulator

A modem **modulates** binary data to frequency shift keyed [FSK] tones which can be transmitted on telephone lines. When receiving such tones the MODEM **demodulates** them to binary computer voltages.

BLOCKDIAGRAM: MODEM



(5)

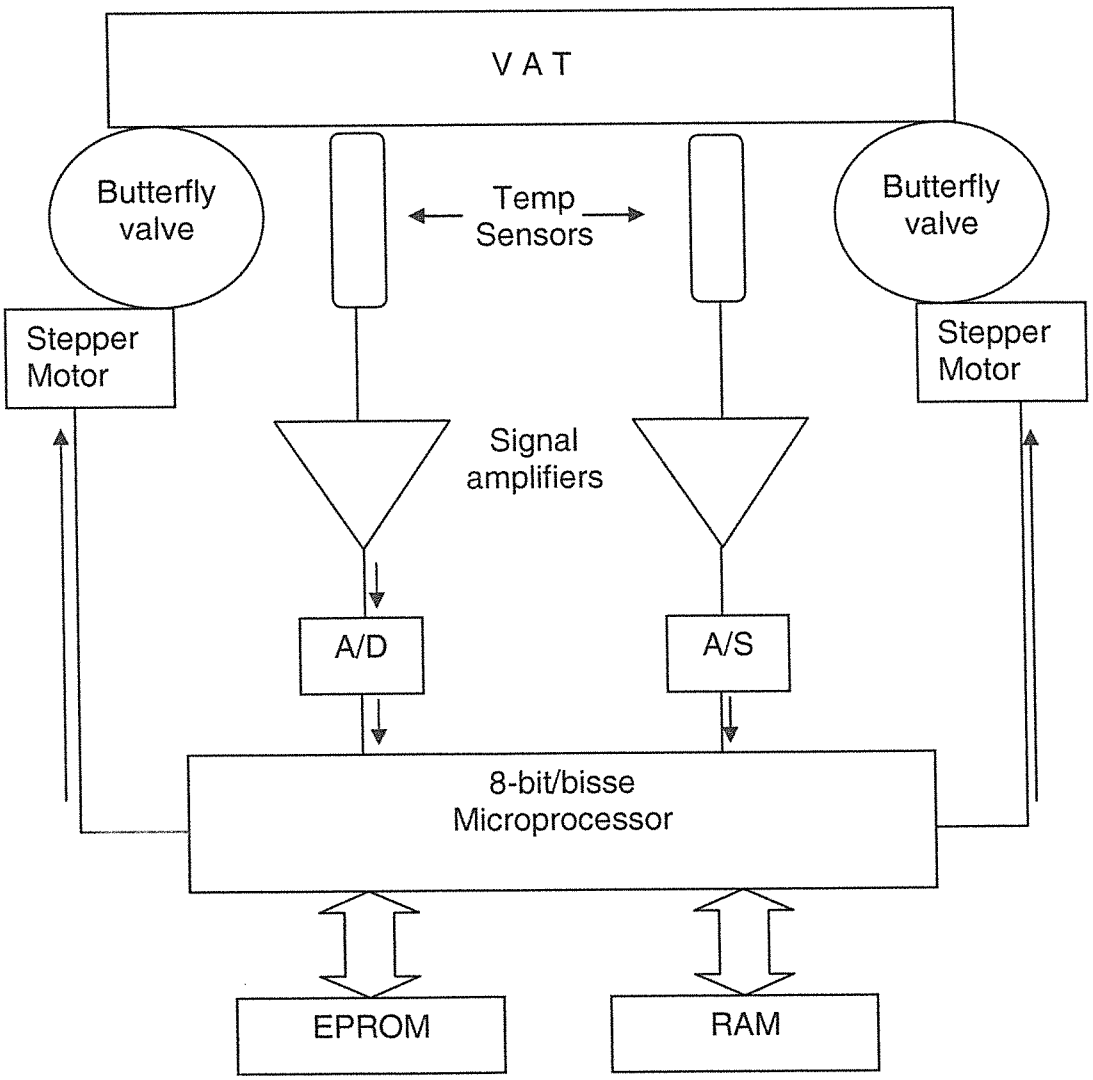
4.3 BELOW IS THE FINAL PRINT-OUT FOR TODAY'S PROGRAM

LIVES DEPEND ON TECHNICIANS AND ENGINEERS

(10)
[20]

QUESTION 5

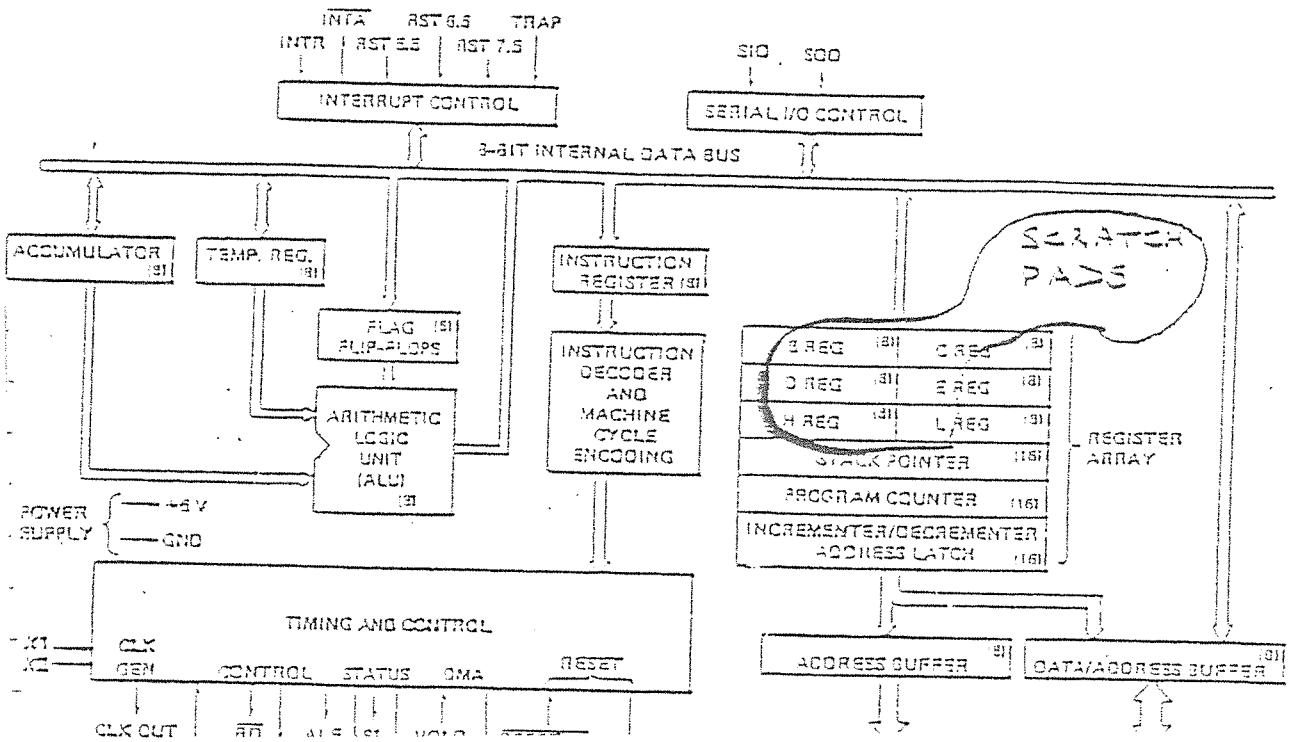
5.1



(10)

5.2 BLOCK DIAGRAM: MICROPROCESSOR

INTEL 8085A CPU



Manufacturer: INTEL CORP (7)

5.3 Advantages of using a microcontroller:

- Programmable A/D and D/A.
- Configurable Input/Output points.
- SOFTWIRING instead of hardwiring interfacing and support functions. (3)

[20]

TOTAL: 100