higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T410(E)(J29)T
AUGUST EXAMINATION

NATIONAL CERTIFICATE

DIGITAL ELECTRONICS N6

(8080376)

29 July 2014 (Y-Paper)
13:00–16:00

This question paper consists of 6 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 correctly according to the numbering system used in this question paper.
4. 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. (1)

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.

Provide 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. (7)

1.3 Determine the decimal equivalent of the following 12-bit computer value which is represented in floating point form:

a	b	c	d
0	010	1	0011111

Where a = sign bit b = exponent
c = sign bit d = mantissa (2)

1.4 Draw a fully labelled block diagram of a CNC (Computer Numeric Controlled) profile cutting production system. (6)

1.5 Explain the operation of the CNC profile cutting production system. (4)
[20]

QUESTION 2

2.1 Name the programming language used to code the program segment in QUESTION 2.3. (1)

2.2 Name the TWO English words which represent the name (an acronym) of a programming language. (1)

2.3 Determine the output of the following program segment:

SHOW every step in your tracking matrix.

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

```
MYBABY= 5
IFULLSUM = 0
884 IFULLSUM = IFULLSUM + MYBABY
MYBABY = MYBABY + 4
IF (MYBABY.LT.26) GO TO 884
PRINT, MYBABY, IFULLSUM
STOP
END
```

(8)

2.4 The following ASCII values must be transmitted using RZ (Return to Zero) PCM (Pulse Code Modulation).

Use THREE bits per packet and draw an RZ-PCM graph to show how the values are represented in unipolar-binary PCM format.

NOTE: Do NOT make any adjustment to your graphical representation in order to change the following sequence of transmission.

PACKET	PACKET	PACKET	PACKET	PACKET
0110011	0110010	0110011	0110100	0110101

(5)

2.5 A five-bit D/A converter has a 10 mV output for a digital input of 10100.

What is the output voltage if the input is 10111?

HINT: Use a sketch to work this out. (5)

[20]

QUESTION 3

3.1 Simplify the following complex logic network using minimisation techniques of your choice. Implement De Morgan's theorem where necessary. Draw the simplest gate network possible. Alternatively indicate to what logic level you would connect the output.

F = (ABC)(ABC)(ABC)(ABC)(ABC) (5)

3.2 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)

3.3 Explain the function in the modem in QUESTION 3.2. Draw a block diagram of a modem. Show the directions of data transmission and reception. Show ALL interfacing and signal processing elements. (5)

3.4 Explain the synchronous transfer of data between modems. Explain how this method eliminates the need for 'start and stop bits'. (5)
[20]

QUESTION 4

4.1 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.

Name the microprocessor and give the name of the manufacturer. (7)

4.2 Draw a fully labelled block diagram of a master/slave computer system. Explain the operation of the system. What are the advantages of such a system? (6)

4.3 Use the following assembler instruction set. You may NOT add instructions to the repertoire. Calculate the value of Y given that Y = D – 4(B + C) and that D, B and C are stored in consecutive memory locations beginning with hexadecimal address 300. Output Y to the computer screen (or alternatively to the printer). Use the correct programming fields. The first instruction location is address 001H. Close the program to limit memory use to the program lines used.

INSTRUCTION REPETOIRE	
MNEMONIC OP-CODE	**DESCRIPTION**
LDA	Load accumulator
ADD	Add
SUB	Subtract
STR	Store
OUT	Output
STP	Stop

(7)
[20]

QUESTION 5

Harvard Architecture is characterised by a memory (usually EPROM) which contains only the program and is distinct from the RAM. The questions that follow are based on the more familiar Von Neumann Architecture where a common RAM holds ALL data and program instructions.

5.1 Draw a fully labelled block diagram of a control unit integrated with a RAM (Random Access Memory). ALL the gates and the interconnections between the micro-instruction unit, program counter, RAM, instruction unit, decoder and arithmetic unit MUST be shown. (10)

5.2 Each micro-instruction in the control unit of QUESTION 5.1 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 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. The contents of address 0000 is 1111 1111

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

5.3 Explain whether the last micro-instruction in QUESTION 5.2 is a DO-nothing phase or NOT. (2)
[20]

TOTAL: 100

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MARKING GUIDELINE

NATIONAL CERTIFICATE

AUGUST EXAMINATION

DIGITAL ELECTRONICS N6

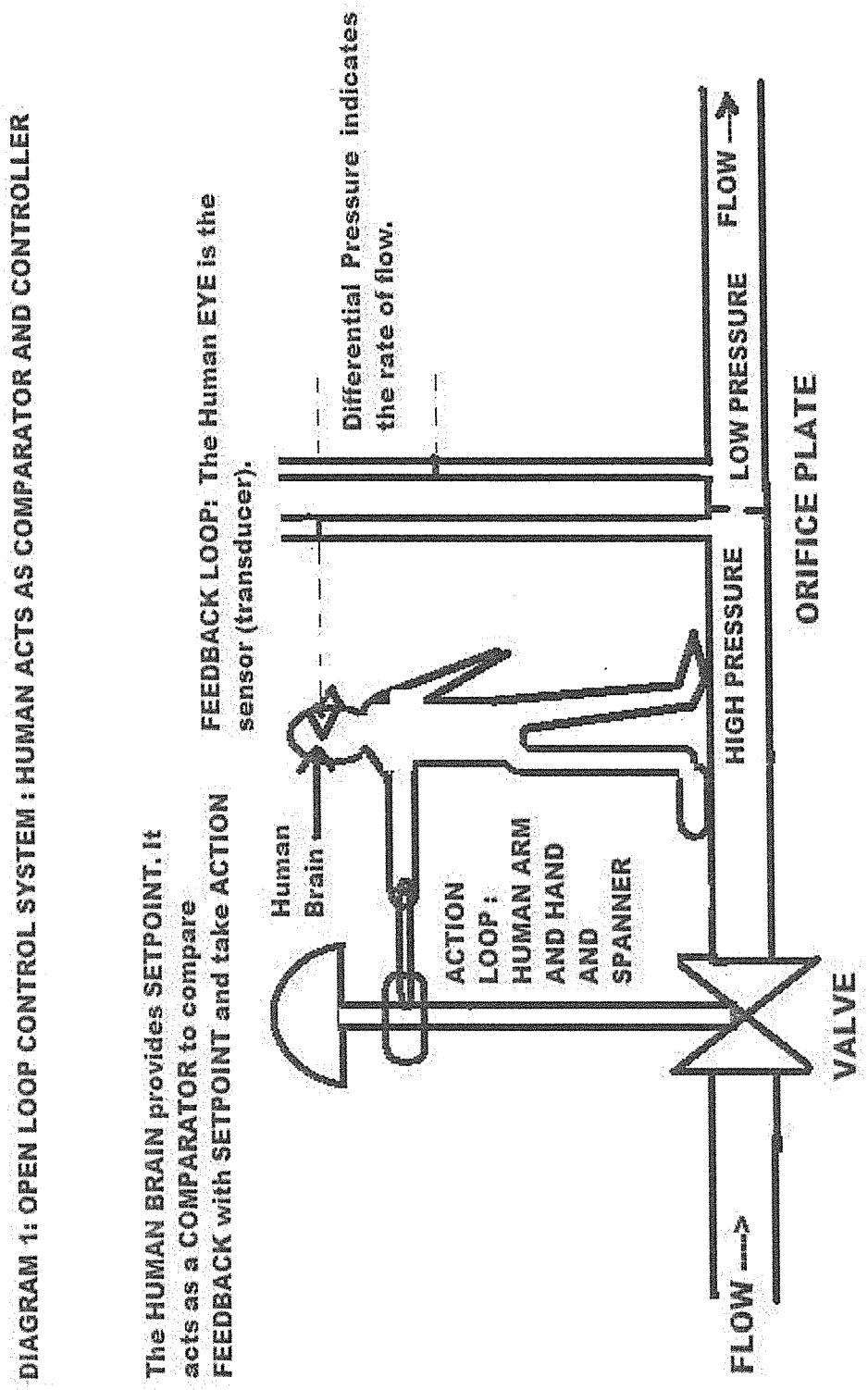
29 JULY 2014

This marking guideline consists of 11 pages.

QUESTION 1

1.1 The element which acts as a comparator and controller in an open loop system is a HUMAN BEING. (1)

1.2



√ √ √ √ √

(7)

1.3 O 010 1 0011111 (2/c)

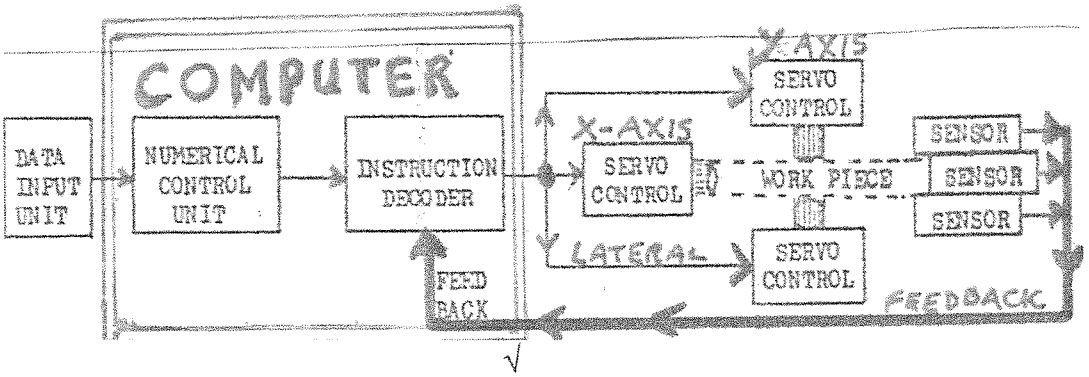
2 places

-1100001

$-11,0000\ \frac{2^{-5}}{1_2}$

$= -3,03125_{10}$ (2)

1.4 CNC (COMPUTER NUMERIC CONTROLLED) PROFILE CUTTING PRODUCTION SYSTEM √



√ √ √ √ √ (6)

1.5 **OPERATION:**

(1)

- Data, program modifications and setpoints are entered via the data Input Unit (Keyboard, Touch screen, Mouse). √
- The cutting-tool is moved sequentially to cut profiles at specified X- and Y-coordinates. √
- The feedback loop transmits a signal at the completion of each step of the job. √
- After completion of each step is fed back, the computer moves the cutting tool to cut the next section until the whole job is complete (4)

[20]

QUESTION 2

2.1 FORTRAN (1)

2.2 FORMULA TRANSLATION (1)

2.3 TRACKING MATRIX

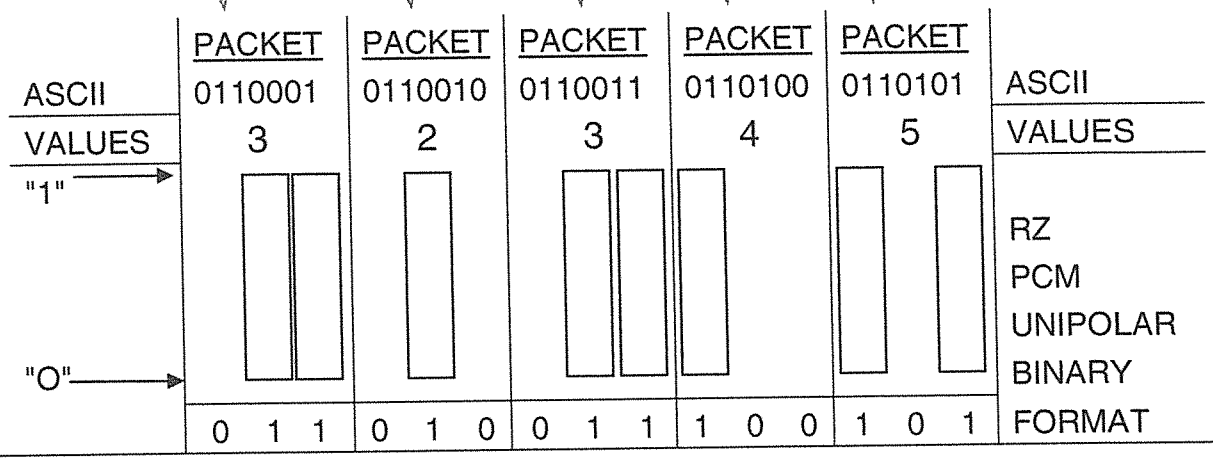
OPERATION NUMBER	PASS NUMBER	VARIABLES	√
		MYBABY	IFULLSUM
1	1	5	
2			0
3			5
4		9	
5	2		14
6		13	
7	3		27
8		17	
9	4		44
10		21	
11	5		65
12		25	
13	6		90
14		29	

√ √ √ √

OUTPUT
29 90 √ √ √ (8)

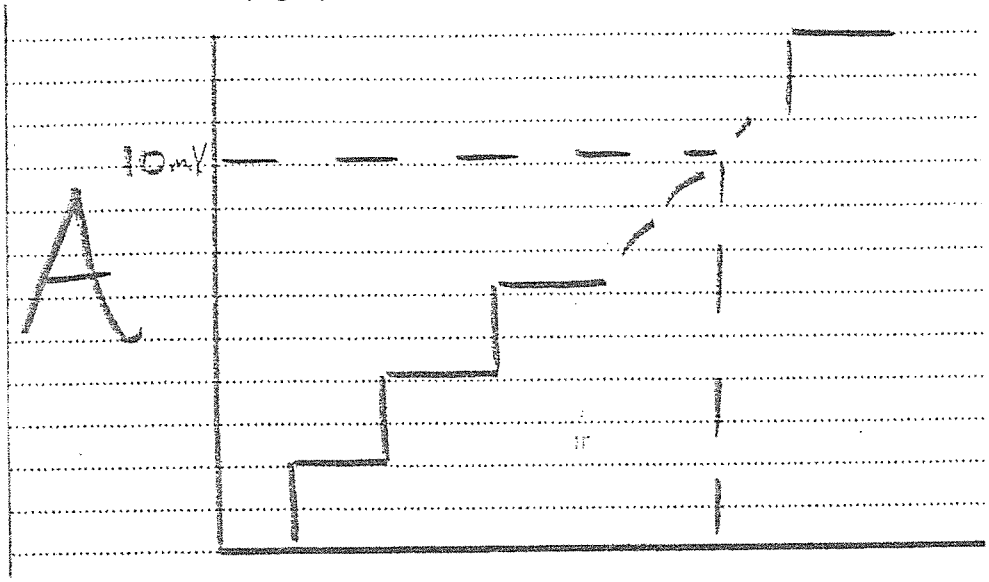
2.4 GRAPHICAL FORMAT: RZ PCM

√ √ √ √ √



(5)

2.5 D/A converter step graph:



$10100_2 = 20$ steps

$$\text{Resolution (Step size)} = \frac{10\,\text{mV}}{20} = 0{,}5\,\text{mV}$$ √ √

Output voltage for $10111_2 = 23_{10}$- = 23 steps

23 steps × 0,5 = 11,5 mV = V_{out} √ √ √

(5)
[20]

QUESTION 3

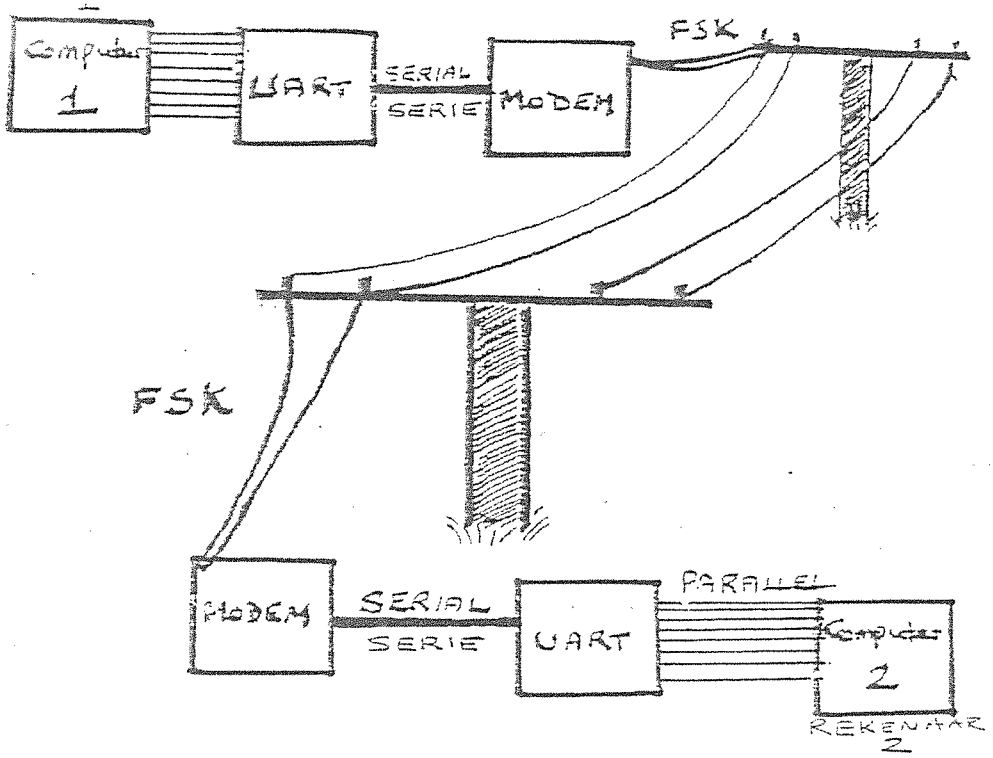
3.1 F = (ABC)(ABC)(ABC)(ABC)(ABC) (The rule to apply here is A.A = A) √

F = ABC √ √ √ √

NOTE: The necessary AND gate. must be drawn to obtain full marks. (5)

3.2 **INTERFACING WITH: INTERNET**

INTERNET COMPUTER √



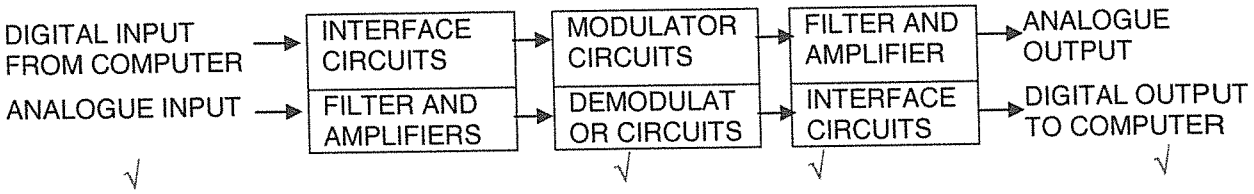
INTERNET SUBSCRIBER'S COMPUTER√ (5)

3.3 **FUNCTION OF A MODEM**

MODEM: Acronym for **MOD**ulator/**DEM**odulator

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. √

{BLOCK DIAGRAM: MODEM}

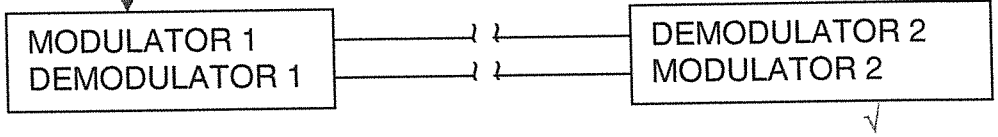


(5)

3.4 **SYNCHRONOUS DATA TRANSFER BETWEEN MODEMS.**

METHOD: HANDSHAKING√

STEP: (1) MODEM CLOCK SYNCHRONISATION √



STEP: (2) Bit count during transfer

No start and stop bits

Bit counting delimits characters

√

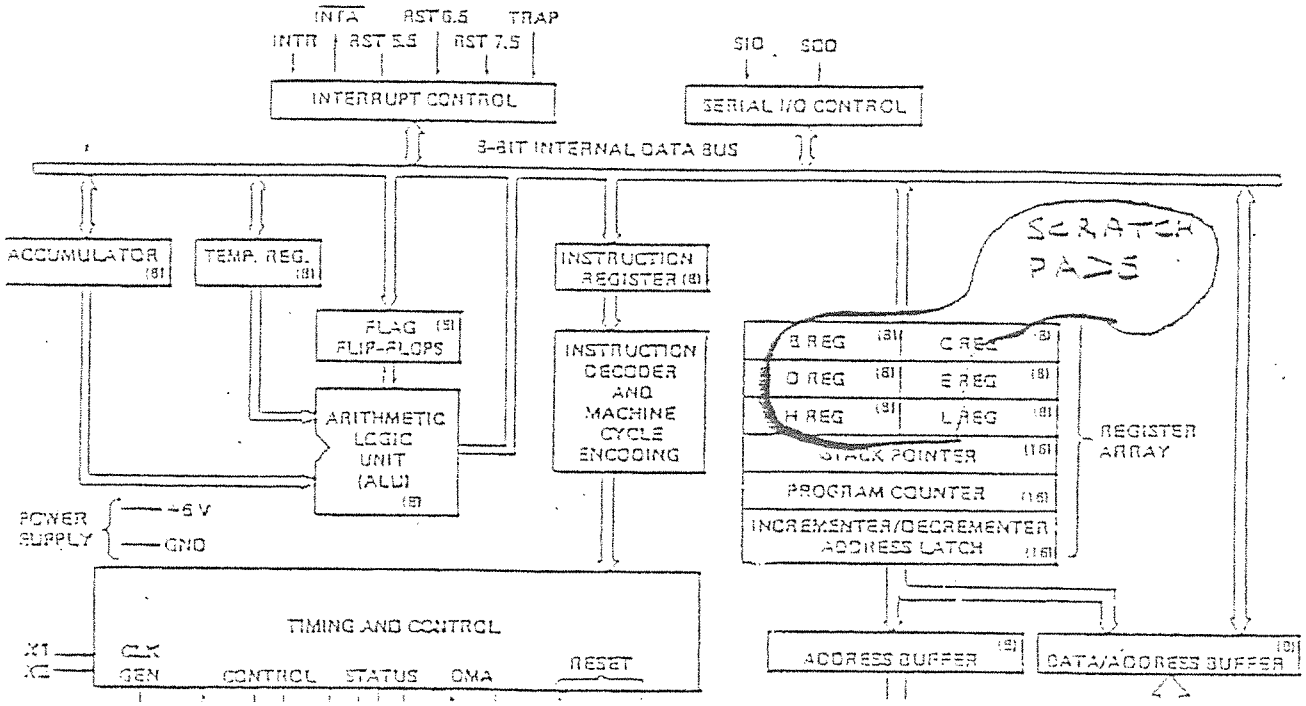
A Two-Wire **'send-receive'** system accomplishes the above. √ (5)

[20]

QUESTION 4

4.1 BLOCK DIAGRAM: MICROPROCESSOR √

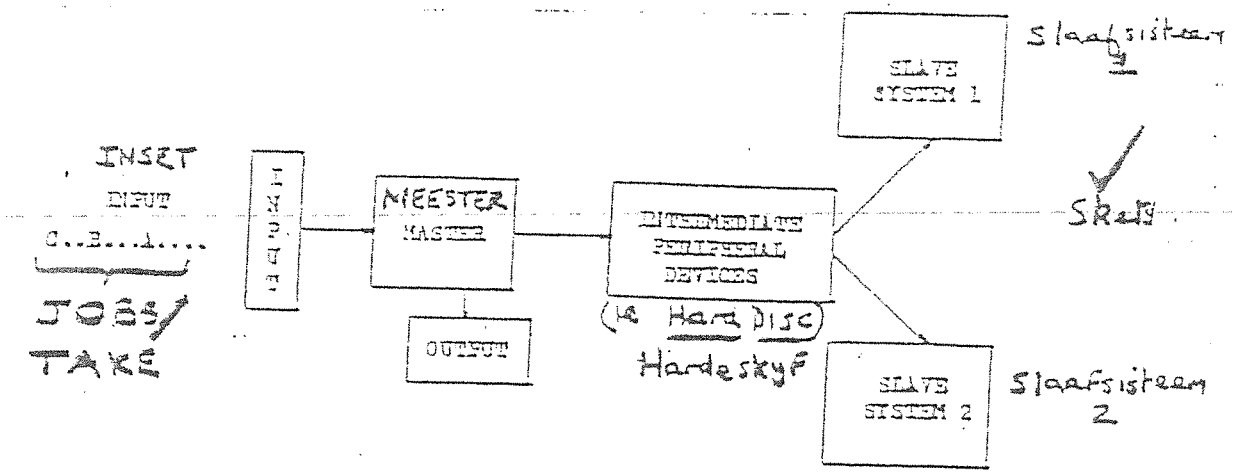
INTEL 8085A CPU



√ √ √ √

(7)

4.2 MASTER-SLAVE COMPUTER SYSTEM



√ √ √ √

OPERATION OF THE MASTER-SLAVE SYSTEM: The MASTER allocates a job to a high-speed slave by placing the job (i.e. program and data) onto the hard disc.
When the slave completes the job, it will find another already allocated on the hard disc. √

ADVANTAGE of the MASTER-SLAVE JOB ALLOCATION SYSTEM:
Good use of computer time. √ (6)

Calculate: $Y = D - 4(B + C) = D - 4B - 4C = D - B - B - B - B - C - C - C - C$ √

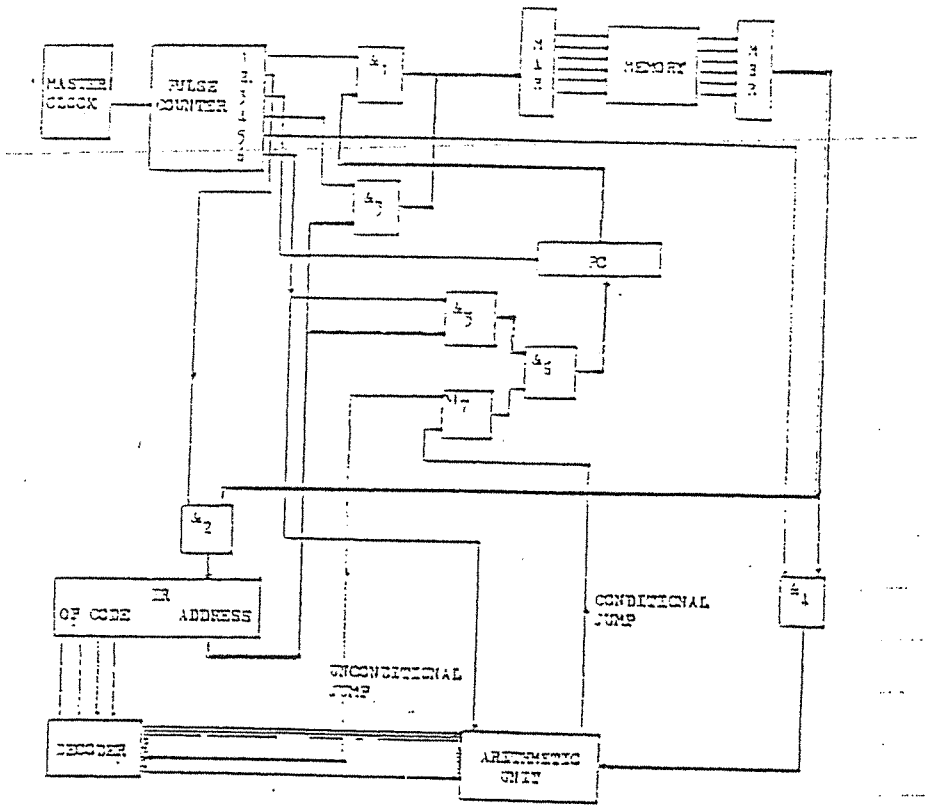
4.3 √

INSTRUCTION LOCATION	INSTRUCTION NWORD		DESCRIPTION
	OP-CODE	ADDRESS	
001	LDA	300	Load D
002	SUB	301	Sub B
003	SUB	301	Sub B
004	SUB	301	Sub B
005	SUB	301	Sub B
006	SUB	302	Sub C
007	SUB	302	Sub C
008	SUB	302	Sub C
009	SUB	302	Sub C
00A	STR	303	Store Y
00B	OUT		Output Y
00C	STP		Stop
√	√	√	√ √

(7)
[20]

QUESTION 5

5.1 CONTROL UNIT

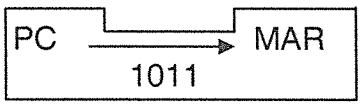


(10)

5.2 FETCH ROUTINE

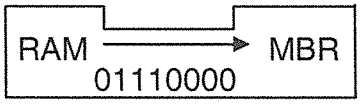
First micro-instruction: **Pulse 1**

PC Contents → MAR



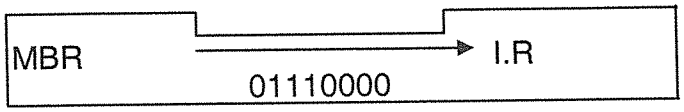
Programteller Geheue Address Register

INSTRUCTION [OP-CODE PLUS OPERAND ADDRESS] → MBR



Second micro-instruction: **PULSE 2**

INSTRUCTION [OP-CODE PLUS THE OPERAND ADDRESS]
→ = INSTRUCTION REGISTER **PULSE 2** √



INSTRUKSIE REGISTER

✓

✓

Third Micro-instruction: **Pulse 3**

Program counter incremented

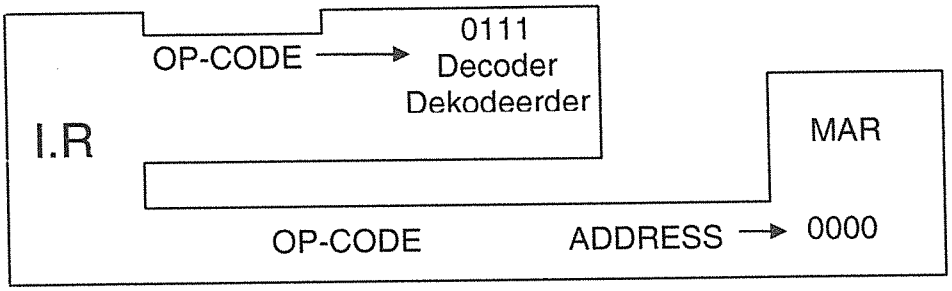
PC = PC + 1 1011 + 1 PC

EXECUTE ROUTINE

√

Fourth Micro-instruction: **Pulse 4**

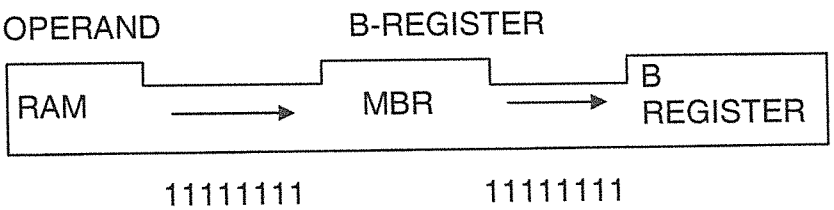
Instruction-word is SPLIT:√



√

√

Fifth micro-instruction: **Pulse 5**



√

Sixth micro-instruction: **Pulse 6**

A.L.U/A.L.E. : (A ← A + B) } LOOK: **ADD** !! √ (8)

5.3 IT IS A **DO-SOMETHING** AND THE SOMETHING TO BE DONE IS **ADD** SO IT IS **NOT** A DO-NOTHING PHASE. √ √ (2)
[20]

TOTAL: 100