

2201/303

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MICROPROCESSOR SYSTEMS

Oct./ Nov. 2011

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

**DIPLOMA IN ELECTRONICS ENGINEERING
DIPLOMA IN TELECOMMUNICATIONS ENGINEERING
DIPLOMA IN INSTRUMENTATION AND CONTROL ENGINEERING**

MICROPROCESSOR SYSTEMS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;

8080/85 microprocessor instruction set;

Electronic calculator.

*Answer any **FIVE** of the **EIGHT** questions in this paper.*

***ALL** questions carry equal marks.*

Maximum marks for each part of a question are shown.

This paper consists of 8 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

1. (a) Draw a block diagram of an 8-bit microprocessor and state the function of each part. (7 marks)

(b) A hypothetical microprocessor has an instruction set as shown in Table 1.

(i) Using the microprocessor instruction set, write an assembly language program to perform the following:

$$6 + 9 - 4$$

(ii) With the aid of a trace table, determine the contents of the accumulator after the execution of the program in table 2. (9 marks)

Table 1.

| OPcode (Hex) | Mnemonic | Explanation |
|--------------|----------|--------------------------------|
| BB | ADD L8 | Add byte to Accumulator |
| FO | SUB L8 | Subtract byte from Accumulator |
| 4C | INC A | Increment the Accumulator |
| 4A | DEC A | Decrement the Accumulator |
| F6 | LD A, L8 | Move byte into the Accumulator |
| 96 | STOP | Halt the microprocessor |

Table 2.

| Address (Hex) | OPcode (Hex) |
|---------------|--------------|
| 8001 | F6 |
| 8002 | 07 |
| 8003 | FO |
| 8004 | 03 |
| 8005 | 4C |
| 8006 | 4C |
| 8007 | 96 |

(c) Differentiate between:

(i) a mainframe computer and a microcomputer;

(ii) analogue and digital computer. (4 marks)

2. (a) Define the following as applied to memories:

(i) access time;

(ii) dynamic. (2 marks)

- (b) An 8-bit microprocessor has a total addressable memory space of 64 Kbytes. The memory is organised such that the first 16 Kbytes is ROM, the next 8 Kbytes is reserved for future expansion, then followed by 32 Kbytes of RAM. The remaining space is also reserved for future expansion.
- (i) Determine the:
 - I. number of address lines for the microprocessor;
 - II. total amount of memory reserved for future expansion.
 - (ii) Draw the microcomputer memory map, labelling the start and end addresses of each region, in hexadecimal.
 - (iii) If the available ROM chips are 8K x 8 and RAM chips are 8K x 8:
 - I. determine the number of chips required to implement each memory type;
 - II. draw a labelled schematic block diagram to illustrate the implementation of the memory map for the RAM only. (18 marks)

3 Table 3 shows an 8085 assembly language program.

Table 3

| Line | Label | Instruction |
|------|--------|-----------------------|
| 1 | | ORG 1100H |
| 2 | | COUNT EQU 04 H |
| 3 | | LX1 H, 1150H |
| 4 | | MVI C, COUNT |
| 5 | | XRA A |
| 6 | AGAIN: | ADD M |
| 7 | | INX H |
| 8 | | DCR C |
| 9 | | JNZ AGAIN |
| 10 | | STA MEM |
| 11 | | HLT ORG 1150 H |
| 12 | | DB 45H, 41H, 43H, 47H |
| 13 | | ORG 1170 H |
| 14 | MEM: | DS 1 |
| 15 | | END |

- (a) List any **four** directives used in the program. (2 marks)
- (b) Draw a flowchart for the program and explain the program's purpose. (8 marks)

- (c) Determine the contents of registers A, H and L at the end of program execution. (6 marks)
- (d) State how to modify the program to keep the purpose of the program if the instructions at line 11 and 12 are changed as shown in Table 4. (2 marks)

Table 4

| |
|---------------------------------|
| 13: ORG 2500H |
| 16: DB 45H, 41H, 43H, 47H, 49H. |

- (e) State **two** advantages of low level language programs. (2 marks)

4. (a) With reference to instruction execution, define the following:

- (i) instruction cycle;
- (ii) machine cycle;
- (iii) T-state. (3 marks)

(b) Table 5 shows a DELAY subroutine.

Table 5

| Line | Label | Instruction | No. of T-states |
|------|-------|--------------|-----------------|
| 1 | | LX1 H, 2000H | 10 |
| 2 | LOOP: | DCX H | 6 |
| 3 | | NOP | 4 |
| 4 | | NOP | 4 |
| 5 | | MOV A, H | 4 |
| 6 | | ORA L | 4 |
| 7 | | JNZ LOOP | 10/7 |
| 8 | | RET | 10 |

- (i) Assuming a clock frequency of 10 MHz, determine:
 - I. time of one T-state;
 - II. total time delay in executing the subroutine.
- (ii) State the addressing modes for each of the instruction at lines 1, 2 and 7. (10 marks)

(c) With the aid of a flowchart, write an assembly language program which will copy a block of 10 bytes of data from RAM memory locations, starting at location 2000H to RAM locations starting at 3000H. (7 marks)

5. Figure 1 shows a water level measuring system. A 8085 microcomputer is connected to a level sensor, through an 8-bit analogue-to-digital converter, which gives 5V when the water tank is 100% full.

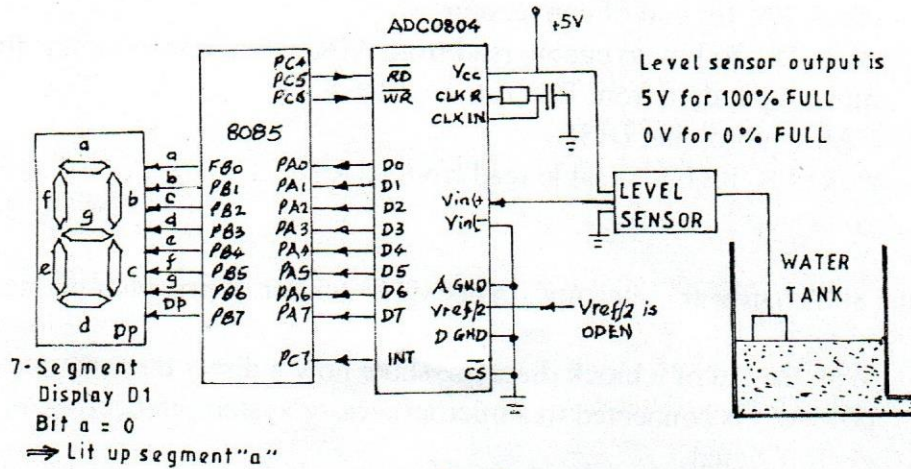


Fig. 1

- (a) If the digital output ($D_0 - D_7$) of the ADC 0804 is E6H, determine the value of the sensor output voltage, V_{in} . (5 marks)
- (b) Table 6 shows the system port configuration.

Table 6

| Port Name | Address |
|--|---------|
| Control (CSR) | 40 |
| Port A | 41 |
| Port B | 42 |
| Port C | 43 |
| Control byte (Port A = Input, Port B = Output, Port C = handshake) = 8AH | |

- (i) Write an 8085 assembly subroutine 'DISP' according to the following algorithm.

DISPLAY ROUTINE

- compare the input tank level accumulator A with E6H
- if $A > E6H$, display letter 'H' in the seven segment display D1, else display letter 'C'
- call the subroutine 'DELAY'
- return to main program.

NB: Assume the subroutine 'DELAY' is available.

(ii) Write the 8085 main program according to the following algorithm.

1. set port A as input, Port B as output and Port C as handshake
2. make PC_6 from low-to-high to start ADC conversion
3. check PA_7 for end of conversion
4. make PC_5 to low to enable read from ADC when conversion is finished
5. move input data from Port A to register A
6. CALL subroutine DISP
7. make PB_5 high to disable read from ADC
8. go to step 1.

(15 marks)

6. (a) List the 8085 hardware interrupts in decreasing order of priority ranking. (5 marks)

(b) (i) With the aid of a block diagram, show how a direct memory Access controller (DMAC) is connected to a microprocessor system, indicating all the main control signal.

(ii) Outline the operation of the system in b(i). (8 marks)

(c) (i) Write an assembly language subroutine to generate the waveform of figure 2 (a). Assume that a delay subroutine is available.

(ii) Modify the program in c(i) to generate the waveform of fig 2 (b). (7 marks)

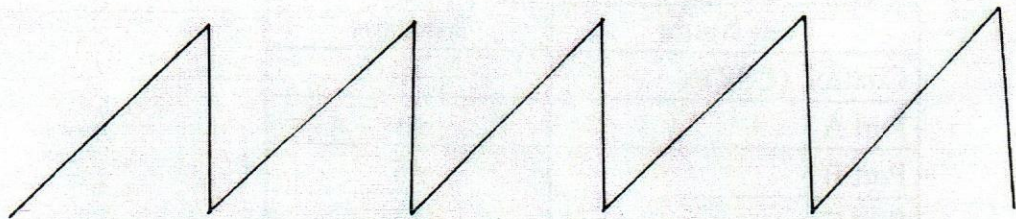


Fig. 2 (a)

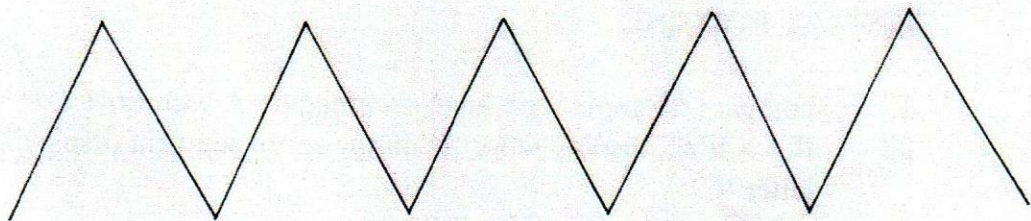


Fig 2 (b)

7. (a) (i) State the function of each of the following software development aid:
- I. text editor;
 - II. debugger;
 - III. loader;
 - IV. macro instruction.
- (ii) With the aid of a block diagram, describe how an in-circuit emulator (ICE) is used in the development of a microprocessor-based system. (12 marks)
- (b) Describe any **four** functions of an operating system. (8 marks)
8. (a) Describe each of the following microcomputer troubleshooting aids:
- (i) single-stepping;
 - (ii) break-point. (4 marks)
- (b) State the function of each of the following 8085 microprocessor signals:
- (i) IO/\overline{M} ;
 - (ii) HOLD;
 - (iii) \overline{INTA} ;
 - (iv) ALE. (5 marks)
- (c) (i) With the aid of a diagram, describe how to test the correct operation of a TTL NOT gate.
- (ii) Draw a block diagram of a logic analyser and state the function of each block. (11 marks)

8080/8085

| OP CODE | MNEMONIC | OP CODE | MNEMONIC | OP CODE | MNEMONIC | OP CODE | MNEMONIC | OP CODE | MNEMONIC | OP CODE | MNEMONIC |
|---------|-----------|---------|-----------|---------|----------|---------|----------|---------|----------|---------|----------|
| 00 | NOP | 2B | DCX H | 56 | MOV D,M | 81 | ADD C | AC | XRA H | D7 | RST 2 |
| 01 | LXI B,D16 | 2C | INR L | 57 | MOV D,A | 82 | ADD D | AD | XRA L | D8 | RC |
| 02 | STAX B | 2D | DCR L | 58 | MOV E,B | 83 | ADD E | AE | XRA M | D9 | - |
| 03 | INX B | 2E | MVI L,DB | 59 | MOV E,C | 84 | ADD H | AF | XRA A | DA | JC Adr |
| 04 | INR B | 2F | CMA | 5A | MOV E,D | 85 | ADD L | B0 | ORA B | DB | IN DB |
| 05 | DCR B | 30 | SIM | 5B | MOV E,E | 86 | ADD M | B1 | ORA C | DC | CC Adr |
| 06 | MVI B,DB | 31 | LXI SPD16 | 5C | MOV E,H | 87 | ADD A | B2 | ORA D | DD | - |
| 07 | RLC | 32 | STA Adr | 5D | MOV E,L | 88 | ADC B | B3 | ORA E | DE | SBI DB |
| 08 | - | 33 | INX SP | 5E | MOV E,M | 89 | ADC C | B4 | ORA H | DF | RST 3 |
| 09 | DAD B | 34 | INR M | 5F | MOV E,A | 8A | ADC D | B5 | ORA L | E0 | RPO |
| 0A | LDAX B | 35 | DCR M | 60 | MOV H,B | 8B | ADC E | B6 | ORA M | E1 | POP H |
| 0B | DCX B | 36 | MVI M,DB | 61 | MOV H,C | 8C | ADC H | B7 | ORA A | E2 | JPO Adr |
| 0C | INR C | 37 | STC | 62 | MOV H,D | 8D | ADC L | B8 | CMP B | E3 | XTHL |
| 0D | DCR C | 38 | -- | 63 | MOV H,E | 8E | ADC M | B9 | CMP C | E4 | CPO Adr |
| 0E | MVI C,DB | 39 | DAD SP | 64 | MOV H,H | 8F | ADC A | BA | CMP D | E5 | PUSH H |
| 0F | RRC | 3A | LDA Adr | 65 | MOV H,L | 90 | SUB B | BB | CMP E | E6 | ANI DB |
| 10 | -- | 3B | DCX SP | 66 | MOV H,M | 91 | SUB C | BC | CMP H | E7 | RST 4 |
| 11 | LXI D,D16 | 3C | INR A | 67 | MOV H,A | 92 | SUB D | BD | CMP L | E8 | RPE |
| 12 | STAX D | 3D | DCR A | 68 | MOV L,B | 93 | SUB E | BE | CMP M | E9 | PCHL |
| 13 | INX D | 3E | MVI A,DB | 69 | MOV L,C | 94 | SUB H | BF | CMP A | EA | JPE Adr |
| 14 | INR D | 3F | CMC | 6A | MOV L,D | 95 | SUB L | C0 | RNZ | EB | XCHG |
| 15 | DCR D | 40 | MOV B,B | 6B | MOV L,E | 96 | SUB M | C1 | POP B | EC | CPE Adr |
| 16 | MVI D,DB | 41 | MOV B,C | 6C | MOV L,H | 97 | SUB A | C2 | JNZ Adr | ED | -- |
| 17 | RAL | 42 | MOV B,D | 6D | MOV L,L | 98 | SBB B | C3 | JMP Adr | EE | ERI DB |
| 18 | --- | 43 | MOV B,E | 6E | MOV L,M | 99 | SBB C | C4 | CNZ Adr | EF | RST 5 |
| 19 | DAD D | 44 | MOV B,H | 6F | MOV L,A | 9A | SBB D | C5 | PUSH B | F0 | RP |
| 1A | LDAX D | 45 | MOV B,L | 70 | MOV M,B | 9B | SBB E | C6 | ADI DB | F1 | POP PSW |
| 1B | DCX D | 46 | MOV B,M | 71 | MOV M,C | 9C | SBB H | C7 | RST 0 | F2 | JP Adr |
| 1C | INR E | 47 | MOV B,A | 72 | MOV M,D | 9D | SBB L | C8 | RZ | F3 | DI |
| 1D | DRC E | 48 | MOV C,B | 73 | MOV M,E | 9E | SBB M | C9 | RET Adr | F4 | CP Adr |
| 1E | MVI E,DB | 49 | MOV C,C | 74 | MOV M,H | 9F | SBB A | CA | JZ | F5 | PUSH PSW |
| 1F | RAR | 4A | MOV C,D | 75 | MOV M,L | A0 | ANA B | CB | --- | F6 | ORI DB |
| 20 | RIM | 4B | MOV C,E | 76 | HLT | A1 | ANA C | CC | CZ Adr | F7 | RST 6 |
| 21 | LXI H,D16 | 4C | MOV C,H | 77 | MOV M,A | A2 | ANA D | CD | CALL Adr | F8 | RM |
| 22 | SHLD Adr | 4D | MOV C,L | 78 | MOV A,B | A3 | ANA E | CE | ACI DB | F9 | SPHL |
| 23 | INX H | 4E | MOV C,M | 79 | MOV A,C | A4 | ANA H | CF | RST 1 | FA | JM Adr |
| 24 | INR H | 4F | MOV C,A | 7A | MOV A,D | A5 | ANA L | D0 | RNC | FB | EI |
| 25 | DCR H | 50 | MOV D,B | 7B | MOV A,E | A6 | ANA M | D1 | POP D | FC | CM Adr |
| 26 | MVI H,DB | 51 | MOV D,C | 7C | MOV A,H | A7 | ANA A | D2 | JNC Adr | FD | -- |
| 27 | DAA | 52 | MOV D,D | 7D | MOV A,L | A8 | XRA B | D3 | OUT DB | FE | CPI DB |
| 28 | --- | 53 | MOV D,E | 7E | MOV A,M | A9 | XRA C | D4 | CNC Adr | FF | RST 7 |
| 29 | DAD H | 54 | MOV D,H | 7F | MOV A,A | AA | XRA D | D5 | PUSH D | | |
| 2A | LHLD Adr | 55 | MOV D,L | 80 | ADD B | AB | XRA E | D6 | SUI DB | | |

DB = constant, or logical/arithmetic expression that evaluates to an 8-bit data quantity. D16 = constant, or logical/arithmetic expression that evaluates to a 16-bit data quantity. Adr = 16-bit address.