Lab: 3
Familiarization with Logical Instructions

Logical Operations

A microprocessor is basically a programmable logic chip. It can perform all the logic functions of the hard-wired logic through its instruction set. The 8085 instruction set includes the logic functions such as AND, OR, XOR, NOT (complement), ROTATE accumulator content, and COMPARE with accumulator.

a) Logical AND (`ANA, ANI`)

These type of instructions does the bitwise AND operation with the accumulator. ANDing operation sets AC and reset CY flag and other flags are affected as according to the result of the operation. The reg/mem content is ANDed with the accumulator content. These instructions are used as follows:

```
ANA R/M
ANI 8-bit
```

`ANA R/M` instruction ANDs the content of accumulator with the register or memory content pointed by H&L register.

`ANI 8-bit` instruction ANDs the content of the accumulator with the immediate 8-bit data

Example 1: Load the following program:

```
8000 MVI A, 82H
8002 MVI B, 54H
8004 ANA B
8005 ANI 45
8007 RST 5
```

Run the program in SS mode and examine the content of concerned registers and flags before and after the execution of instruction `ANA B` and `ANI 45`

Assignments

1. Write a program to AND the content of reg B and content of memory at 9030. Assume the content of 9030 as 34 and reg B as 92.
2. Write a program that will check whether D_4 bit of data at address 9030 is zero. Just check the result after the operation.

b) Logical OR and XOR (`ORA, ORI, XRA, XRI`)

These types of instructions perform ORing or XORing of 8-bit of the reg/mem content or immediate data with the 8-bit data of the accumulator. ORing/XORing operation resets AC and CY flag and all the other flags are affected as according to the result of the operation. These instructions are used as follows.

```
ORA R/M
ORI 8-bit
XRA R/M
XRI 8-bit
```

`ORA R/M` (`ORI 8-bit`) instruction ORs the accumulator content with the reg/mem (or immediate data) content and stores the result in accumulator. The `XRA R/M (XRI 8-bit)` instruction performs Exclusive-ORing of eight bits of the operands (acc and reg/mem or acc and immediate data). `XRA` can also be used to clear the content of the accumulator. **Example 2:** Load the following program and check the content of the respected registers and flag contents before and after `XRA` and `ORA` operations. Check out the `XRI` and `ORI` operations yourself.

```
8000 MVI A, 8F
8002 MVI C, A2
8004 ORA C
8005 MVI D, 74
8007 XRA D
8008 RST 5
```

Assignments

3. The content of the memory is shown in the figure along side. Write a program to OR the content of memory location 9024 with the memory location 9025 and store the result at 9026.
4. Write a program to XOR the content of 9027 with the location 9028 and store the content at 9029.

9024	A2
9025	79
9026	
9027	4B
9028	C4
9029	

5. Logical instructions can also be used to mask certain bits of a word. Write a program to complement bit D_6 of data at memory location 9025. Assume data as shown in the above figure.

c) Logical NOT and Compare (CMA, CMP, CPI)

For the NOT operation CMA instruction is used. CMA is a one byte instruction without any operand. It complements (NOT) the accumulator content. E.g., if the content of accumulator is 56H CMA instruction complements it to A9H. Verify this result.

CMP R/M (CPI 8-bit) instruction is used to compare the accumulator content with the reg/mem (or the immediate data). The compare instruction first subtracts the reg/mem content (or immediate data) from the accumulator content and the flags are affected according to the result of the subtraction, but the result is not stored. The flags are affected as follows.

If A < (Reg/Mem/Data) :CY flag is set and Z flag is reset
If A = (Reg/Mem/Data) :Z flag is set and CY flag is reset
If A > (Reg/Mem/Data) :CY flag and Z flag are reset

Example 3: Load the following program and check out the flag contents to find which number is greater.

```
8000 MVI A, 72H
8002 LXI H, 8010
8005 CMP M
8006 CMP H
8007 CPI 72H
8008 RST 5

8010 A7 DATA
```

Run this program and see the effect of different CMP instructions in the program. Note down the flag condition during execution of each CMP, CPI instructions.

Assignment

6. We can complement the accumulator content by using instruction other than CMA How is that possible? Write a program to illustrate this.

7. Write a program to compare the content of the memory location 8081 and 8082. Subtract the memory content at 8082 from 8081 and see whether the flag content is same as the compare instruction or not.

8081	36
8082	A4
8083	

d) Rotating Instructions (RLC, RRC, RAL, RAR)

All the rotating instructions are one byte instructions without the operand. The operand is always the accumulator. Only the carry flag is affected.

RLC and RAL instructions are used to rotate the content of the accumulator to left. The RLC instruction rotates the accumulator left without the carry but the RAL instruction rotates the accumulator left through the carry.

RRC and RAR instructions rotate the accumulator right. RRC instruction rotates right without the carry but RAR instruction rotates right through carry.

Rotating right can be thought as the dividing the number by 2 and rotating left can be considered as multiplying by 2.

Example 4: Load the following program and view the content of the accumulator in each step.

```
8000 MVI B, 18
8002 MOV A, B
8004 RAL
8005 RLC
8006 MOV A, B
8007 RAR
8008 RRC
8009 RST 5
```

Run this program and view the flags and accumulator content in each step.

Assignment:

8. Write a program to check the bit D_5 of the content of memory at 9025. Display 1 at port A if the bit is 1 else displays nothing. Use the rotating instructions after masking. Use the rotating instruction which uses less no of instructions.
9. Change the program in assignment 8 to display 80H if the bit is 1 else nothing.