Instruction Set of 8086

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Instruction Set of 8086

• An instruction is a binary pattern designed inside a microprocessor to perform a specific function.

• The entire group of instructions that a microprocessor supports is called Instruction Set.

• 8086 has more than 20,000 instructions.
Classification of Instruction Set

- Data Transfer Instructions
- Arithmetic Instructions
- Bit Manipulation Instructions
- Program Execution Transfer Instructions
- String Instructions
- Processor Control Instructions
Data Transfer Instructions

- These instructions are used to transfer data from source to destination.

- The operand can be a constant, memory location, register or I/O port address.
Data Transfer Instructions

• **MOV Des, Src:**
  - Src operand can be register, memory location or immediate operand.
  - Des can be register or memory operand.
  - Both Src and Des cannot be memory location at the same time.
  - E.g.:
    - MOV CX, 037A H
    - MOV AL, BL
    - MOV BX, [0301 H]
Data Transfer Instructions

• **PUSH Operand:**
  • It pushes the operand into top of stack.
  • E.g.: PUSH BX

• **POP Des:**
  • It pops the operand from top of stack to Des.
  • Des can be a general purpose register, segment register (except CS) or memory location.
  • E.g.: POP AX
Data Transfer Instructions

- **XCHG Des, Src:**
  - This instruction exchanges Src with Des.
  - It cannot exchange two memory locations directly.
  - E.g.: XCHG DX, AX
Data Transfer Instructions

- **IN Accumulator, Port Address:**
  - It transfers the operand from specified port to accumulator register.
  - E.g.: IN AX, 0028 H

- **OUT Port Address, Accumulator:**
  - It transfers the operand from accumulator to specified port.
  - E.g.: OUT 0028 H, AX
Data Transfer Instructions

- **LEA Register, Src:**
  - It loads a 16-bit register with the offset address of the data specified by the Src.
  - E.g.: LEA BX, [DI]
    - This instruction loads the contents of DI (offset) into the BX register.
Data Transfer Instructions

- **LDS Des, Src:**
  - It loads 32-bit pointer from memory source to destination register and DS.
  - The offset is placed in the destination register and the segment is placed in DS.
  - To use this instruction the word at the lower memory address must contain the offset and the word at the higher address must contain the segment.
  - E.g.: LDS BX, [0301 H]
Data Transfer Instructions

- **LES Des, Src:**
  - It loads 32-bit pointer from memory source to destination register and ES.
  - The offset is placed in the destination register and the segment is placed in ES.
  - This instruction is very similar to LDS except that it initializes ES instead of DS.
  - E.g.: LES BX, [0301 H]
Data Transfer Instructions

- **LAHF:**
  - It copies the lower byte of flag register to AH.

- **SAHF:**
  - It copies the contents of AH to lower byte of flag register.

- **PUSHF:**
  - Pushes flag register to top of stack.

- **POPF:**
  - Pops the stack top to flag register.
Arithmetic Instructions

• **ADD Des, Src:**
  - It adds a byte to byte or a word to word.
  - It effects AF, CF, OF, PF, SF, ZF flags.
  - E.g.:
    - ADD AL, 74H
    - ADD DX, AX
    - ADD AX, [BX]
Arithmetic Instructions

- **ADC Des, Src:**
  - It adds the two operands with CF.
  - It effects AF, CF, OF, PF, SF, ZF flags.
  - E.g.:
    - ADC AL, 74H
    - ADC DX, AX
    - ADC AX, [BX]
Arithmetic Instructions

• **SUB Des, Src:**
  
  • It subtracts a byte from byte or a word from word.
  
  • It effects AF, CF, OF, PF, SF, ZF flags.
  
  • For subtraction, CF acts as borrow flag.
  
  • E.g.:
    
    • SUB AL, 74H
    
    • SUB DX, AX
    
    • SUB AX, [BX]
Arithmetic Instructions

- **SBB Des, Src:**
  - It subtracts the two operands and also the borrow from the result.
  - It effects AF, CF, OF, PF, SF, ZF flags.
  - E.g.:
    - SBB AL, 74H
    - SBB DX, AX
    - SBB AX, [BX]
Arithmetic Instructions

- **INC Src:**
  - It increments the byte or word by one.
  - The operand can be a register or memory location.
  - It effects AF, OF, PF, SF, ZF flags.
  - CF is not effected.
  - E.g.: INC AX
Arithmetic Instructions

- **DEC Src:**
  - It decrements the byte or word by one.
  - The operand can be a register or memory location.
  - It effects AF, OF, PF, SF, ZF flags.
  - CF is not effected.
  - E.g.: DEC AX
Arithmetic Instructions

- **AAA (ASCII Adjust after Addition):**
  - The data entered from the terminal is in ASCII format.
  - In ASCII, 0 – 9 are represented by 30H – 39H.
  - This instruction allows us to add the ASCII codes.
  - This instruction does not have any operand.

- **Other ASCII Instructions:**
  - **AAS** (ASCII Adjust after Subtraction)
  - **AAM** (ASCII Adjust after Multiplication)
  - **AAD** (ASCII Adjust Before Division)
Arithmetic Instructions

- **DAA (Decimal Adjust after Addition)**
  - It is used to make sure that the result of adding two BCD numbers is adjusted to be a correct BCD number.
  - It only works on AL register.

- **DAS (Decimal Adjust after Subtraction)**
  - It is used to make sure that the result of subtracting two BCD numbers is adjusted to be a correct BCD number.
  - It only works on AL register.
Arithmetic Instructions

- **NEG Src:**
  - It creates 2’s complement of a given number.
  - That means, it changes the sign of a number.
Arithmetic Instructions

- CMP Des, Src:
  - It compares two specified bytes or words.
  - The Src and Des can be a constant, register or memory location.
  - Both operands cannot be a memory location at the same time.
  - The comparison is done simply by internally subtracting the source from destination.
  - The value of source and destination does not change, but the flags are modified to indicate the result.
Arithmetic Instructions

- **MUL Src:**
  - It is an unsigned multiplication instruction.
  - It multiplies two bytes to produce a word or two words to produce a double word.
  - \( AX = AL \times Src \)
  - \( DX : AX = AX \times Src \)
  - This instruction assumes one of the operand in AL or AX.
  - Src can be a register or memory location.

- **IMUL Src:**
  - It is a signed multiplication instruction.
Arithmetic Instructions

- **DIV Src:**
  - It is an unsigned division instruction.
  - It divides word by byte or double word by word.
  - The operand is stored in AX, divisor is Src and the result is stored as:
    - AH = remainder    AL = quotient

- **IDIV Src:**
  - It is a signed division instruction.
Arithmetic Instructions

- **CBW (Convert Byte to Word):**
  - This instruction converts byte in AL to word in AX.
  - The conversion is done by extending the sign bit of AL throughout AH.

- **CWD (Convert Word to Double Word):**
  - This instruction converts word in AX to double word in DX : AX.
  - The conversion is done by extending the sign bit of AX throughout DX.
Bit Manipulation Instructions

- These instructions are used at the bit level.
- These instructions can be used for:
  - Testing a zero bit
  - Set or reset a bit
  - Shift bits across registers
Bit Manipulation Instructions

- **NOT Src:**
  - It complements each bit of Src to produce 1’s complement of the specified operand.
  - The operand can be a register or memory location.
Bit Manipulation Instructions

- **AND Des, Src:**
  - It performs AND operation of Des and Src.
  - Src can be immediate number, register or memory location.
  - Des can be register or memory location.
  - Both operands cannot be memory locations at the same time.
  - CF and OF become zero after the operation.
  - PF, SF and ZF are updated.
Bit Manipulation Instructions

- **OR Des, Src:**
  - It performs OR operation of Des and Src.
  - Src can be immediate number, register or memory location.
  - Des can be register or memory location.
  - Both operands cannot be memory locations at the same time.
  - CF and OF become zero after the operation.
  - PF, SF and ZF are updated.
Bit Manipulation Instructions

- XOR Des, Src:
  - It performs XOR operation of Des and Src.
  - Src can be immediate number, register or memory location.
  - Des can be register or memory location.
  - Both operands cannot be memory locations at the same time.
  - CF and OF become zero after the operation.
  - PF, SF and ZF are updated.
Bit Manipulation Instructions

- **SHL Des, Count:**
  - It shift bits of byte or word left, by count.
  - It puts zero(s) in LSBs.
  - MSB is shifted into carry flag.
  - If the number of bits desired to be shifted is 1, then the immediate number 1 can be written in Count.
  - However, if the number of bits to be shifted is more than 1, then the count is put in CL register.
Bit Manipulation Instructions

- **SHR Des, Count:**
  - It shifts bits of byte or word right, by count.
  - It puts zero(s) in MSBs.
  - LSB is shifted into carry flag.
  - If the number of bits desired to be shifted is 1, then the immediate number 1 can be written in Count.
  - However, if the number of bits to be shifted is more than 1, then the count is put in CL register.
Bit Manipulation Instructions

- **ROL Des, Count:**
  - It rotates bits of byte or word left, by count.
  - MSB is transferred to LSB and also to CF.
  - If the number of bits desired to be shifted is 1, then the immediate number 1 can be written in Count.
  - However, if the number of bits to be shifted is more than 1, then the count is put in CL register.
Bit Manipulation Instructions

- **ROR Des, Count:**
  - It rotates bits of byte or word right, by count.
  - LSB is transferred to MSB and also to CF.
  - If the number of bits desired to be shifted is 1, then the immediate number 1 can be written in Count.
  - However, if the number of bits to be shifted is more than 1, then the count is put in CL register.
Program Execution Transfer Instructions

- These instructions cause change in the sequence of the execution of instruction.

- This change can be through a condition or sometimes unconditional.

- The conditions are represented by flags.
Program Execution Transfer Instructions

• CALL Des:
  • This instruction is used to call a subroutine or function or procedure.
  • The address of next instruction after CALL is saved onto stack.

• RET:
  • It returns the control from procedure to calling program.
  • Every CALL instruction should have a RET.
Program Execution Transfer Instructions

- **JMP Des:**
  - This instruction is used for unconditional jump from one place to another.

- **Jxx Des (Conditional Jump):**
  - All the conditional jumps follow some conditional statements or any instruction that affects the flag.
## Conditional Jump Table

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Meaning</th>
<th>Jump Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>JA</td>
<td>Jump if Above</td>
<td>CF = 0 and ZF = 0</td>
</tr>
<tr>
<td>JAE</td>
<td>Jump if Above or Equal</td>
<td>CF = 0</td>
</tr>
<tr>
<td>JB</td>
<td>Jump if Below</td>
<td>CF = 1</td>
</tr>
<tr>
<td>JBE</td>
<td>Jump if Below or Equal</td>
<td>CF = 1 or ZF = 1</td>
</tr>
<tr>
<td>JC</td>
<td>Jump if Carry</td>
<td>CF = 1</td>
</tr>
<tr>
<td>JE</td>
<td>Jump if Equal</td>
<td>ZF = 1</td>
</tr>
<tr>
<td>JNC</td>
<td>Jump if Not Carry</td>
<td>CF = 0</td>
</tr>
<tr>
<td>JNE</td>
<td>Jump if Not Equal</td>
<td>ZF = 0</td>
</tr>
<tr>
<td>JNZ</td>
<td>Jump if Not Zero</td>
<td>ZF = 0</td>
</tr>
<tr>
<td>JPE</td>
<td>Jump if Parity Even</td>
<td>PF = 1</td>
</tr>
<tr>
<td>JPO</td>
<td>Jump if Parity Odd</td>
<td>PF = 0</td>
</tr>
<tr>
<td>JZ</td>
<td>Jump if Zero</td>
<td>ZF = 1</td>
</tr>
</tbody>
</table>
Program Execution Transfer Instructions

- Loop Des:
  - This is a looping instruction.
  - The number of times looping is required is placed in the CX register.
  - With each iteration, the contents of CX are decremented.
  - ZF is checked whether to loop again or not.
String Instructions

- String in assembly language is just a sequentially stored bytes or words.
- There are very strong set of string instructions in 8086.
- By using these string instructions, the size of the program is considerably reduced.
String Instructions

- **CMPS Des, Src:**
  - It compares the string bytes or words.

- **SCAS String:**
  - It scans a string.
  - It compares the String with byte in AL or with word in AX.
String Instructions

- **MOVS / MOVSB / MOVSW:**
  - It causes moving of byte or word from one string to another.
  - In this instruction, the source string is in Data Segment and destination string is in Extra Segment.
  - SI and DI store the offset values for source and destination index.
String Instructions

- **REP (Repeat):**
  - This is an instruction prefix.
  - It causes the repetition of the instruction until CX becomes zero.
  - E.g.: REP MOVSB STR₁, STR₂
    - It copies byte by byte contents.
    - REP repeats the operation MOVSB until CX becomes zero.
Processor Control Instructions

- These instructions control the processor itself.
- 8086 allows to control certain control flags that:
  - causes the processing in a certain direction
  - processor synchronization if more than one microprocessor attached.
Processor Control Instructions

- **STC:**
  - It sets the carry flag to 1.

- **CLC:**
  - It clears the carry flag to 0.

- **CMC:**
  - It complements the carry flag.
Processor Control Instructions

- **STD:**
  - It sets the direction flag to 1.
  - If it is set, string bytes are accessed from higher memory address to lower memory address.

- **CLD:**
  - It clears the direction flag to 0.
  - If it is reset, the string bytes are accessed from lower memory address to higher memory address.
Thank You
Have a Nice Day